SCIENCE ABSTRACTS.

Section A.—PHYSICS

MAY 1922.

GENERAL PHYSICS.

1031. *Principle and Plan of a Geometrically Synchronised Printing Chronograph.* **J. P. Lagrula.** (Comptes Rendus, 173. pp. 1335–1338, Dec. 19, 1921.)—Special points about this apparatus are: (1) It is not necessary that the paper should move with rigorous uniformity. (2) The whole minutes and seconds are printed, and various lines impressed between the seconds, enabling tenths and hundredths to be given at once. (3) The paper only travels when required. It is not claimed that it is superior to the Gautier printing chronograph, but that it is simple and nearly as quick. W. W. B.

1032. *Use of the Water Interferometer as a Pressure Gauge.* **L. van Doren, H. K. Parker,** and **P. Lotz.** (Am. Chem. Soc., J. 44. pp. 2497–2501, Dec., 1921.)—The instrument described consists of a modification of the Zeiss water interferometer. White light from a slit is rendered parallel by means of a collimating lens and then passed through two parallel pressure chambers each consisting of a hollow bronze cylinder fitted at the ends with heavy plate-glass windows. The two beams are reflected from a mirror normal to their path, and pass back through the chambers and lens to unite and form a system of interference fringes, which are viewed by a suitable eyepiece. When the optical paths of the two beams are different, the interference fringes undergo displacement, which is compensated by means of an inclined plate in the path of one of the beams, a similar inclined plate in the path of the other beam being fixed. From the extent of the adjustment necessary to give compensation the pressure on the water in the one chamber may be calculated, that in the other chamber being kept at atmospheric pressure. Just beneath the pressure chambers the bronze cylinder is provided with a longitudinal slot for beams of light which form the stationary bands of reference. The pressure limit of the apparatus may be increased from about 60 to 120 atmos. by inserting in the path of the beam passing through the non-pressure chamber a glass plate of such thickness that it compensates the displacement of the interference fringes caused by a pressure of approximately 60 atmospheres. The apparatus is calibrated with the help of an absolute pressure gauge. T. H. P.

electron in the outer shell are the best conductors. *Solutions.*—The conductivity of dilute aqueous solutions is found *not* to change in exactly the same ratio for different salts, and changes in ionic friction of the solvent must depend in some way on the solute. The general result in dilute solutions at low pressures is a decrease in internal friction, but at higher pressures it increases rapidly.

Compressibility is diminished by pressure, and the effect is immediately seen in the case of liquids, but is shown by all substances experimented with. Diamond is the least compressible substance known, and the highest pressures obtainable only compress diamond by a fraction of 1 %. In general the least compressible substances show least change of compressibility, but there are exceptions, and the two properties are not proportional. *Viscosity* increases considerably with pressure, and kerosene at 12,000 atmos. is more viscous than vaseline at zero pressure.

W. A. R.

1041. *The Compressibility of Liquid and Solid Benzene.* **T. W. Richards, E. P. Bartlett,** and **J. H. Hodges.** (Am. Chem. Soc., J. 43. pp. 1538–1542, July, 1921.)—This brief paper records for the first time an accurate determination of the compressibility of solid benzene at 0°, namely $(\Delta V/\Delta PV_0)_T = 0\cdot0000305$ over the range 100 to 500 megabars. Incidentally, the compressibility of liquid toluene at 0° over the same range was found to be 0·0000618. A new determination of the compressibility of liquid benzene at 20° confirmed satisfactorily the previous determination, giving the value 0·00007207 for the same range. The compressibility of solid benzene is shown to be less than half that of liquid benzene at the same temperature. Thus another case, supporting the majority of those investigated, is found in which the solid shows much smaller compressibility than the liquid. Interpretation of the result will be postponed until more cases of this kind have been studied.

AUTHORS.

1042. *Young's Modulus for Microscope Cover-Glass.* **J. E. P. Wagstaff.** (Cambridge Phil. Soc., Proc. 21. pp. 14–16, Feb., 1922.)—Describes a method for determining the value of Young's modulus, assuming a value for Poisson's ratio, in the case of a glass cover slip. The slip is clamped over a circular hole in a chamber containing slightly compressed air, and its upper surface is a short distance below a small glass plate, which is fixed in position. The movement of the centre of the cover glass as the chamber it covers is gradually emptied of air can be very accurately measured by an interference method, using the upper glass plate as a reference surface. The values obtained are compared with those measured by a second method in which the cover slip was freely supported.

J. W. T. W.

1043. *New Method of Testing Wearing Properties of Metals.* **L. Jannin, L. Guillet.** (Rev. de Mét. 19. pp. 109–116, and pp. 117–119, Feb., 1922.)—The wearing properties of the metals under investigation are tested by pressing a sample of suitable size against a steel cylinder, which is rotated at a constant speed. The pressure is also kept constant, and the width of worn surface, after a constant time of rubbing, is measured with a microscope similar to that used in the determination of Brinell hardness. The author has investigated the effect of the surface of the rotating cylinder, its hardness, the nature of the lubricant used, etc., on the result obtained, and he draws the following conclusions from a series of tests :—(1) The principal cause of wear on the liners of bearings is insufficient polish on the rubbing surface of the journal. (2) The chief cause of wear of the shaft is impurity in the lubricating oil. Certain modifications introduced into the machine are described in the second article, notably the substitution of a cylindrical test-piece for a flat one, and tests, similar to those of Jannin, are carried out with the remodelled machine. In addition the wearing properties of various anti-friction metals, steels, bronzes, etc., in contact with steels of various compositions and an "aluminium bronze" were investigated. The best results were obtained when both surfaces consisted of a cemented and quenched case-hardening steel, and the worst when an "aluminium bronze" rubbed on duralumin. The influence of thermal treatment on the frictional properties of an alloy consisting of Cu 90 %, Al 10 %, was also studied. J. L. H.

1044. *Nature of Rupture by Tensile Stress.* **M. Polányi.** (Zeits. f. Physik, 7. 4. and 5. pp. 323–327, 1921.)—The work to be done in tensile rupture of a rod of cross-section q cannot be smaller than $2\sigma q$, where σ is the surface tension of the ruptured face. In the case of a rocksalt rod of length L_0, stressed in the direction of its axis, fracture takes place in a plane (100) when a certain elongation ΔL_0 is produced, such that $A < Zq\Delta L_0$, where Z is the tensile strength. Hence $Z\Delta L_0 > 2\sigma$, which shows that ΔL_0 must have a certain minimum length, however small L_0 be itself. This λ now comes out far larger for rocksalt than would be expected, much greater than 500 Å.U., according to Voigt and Stella's measurement of the tensile strength, and F. M. Jaeger's of the surface tension. The effective molecular range should be much greater and lie between 1000 and 5000 Å.U., whilst the ionic lattice theory of Born and Landé gives a range of about 3 Å.U. Accepting that theory, the author suggests that the stressed rod of rocksalt first stretches in accordance with the laws of mechanics, but that at a certain stress and elongation a quantum jump takes place, leading to rupture. The relation derived is $Z^2L_0/2E > 2\sigma$, where E is the modulus of elasticity. The ordinary value for the tensile strength should then fail when L_0 sinks below a certain critical value, $L_K > 0{\cdot}6$ cm. That would imply a change in the properties of matter at macroscopic dimensions, far above molecular dimensions. Some experimental confirmation has been obtained by H. Schönborn and I. Peters, and it is pointed out that thermal expansion far exceeds the limits of mechanical stretching, without producing rupture, and that the tensile strength of wires and of rocksalt is only increased from 50 to 80 % when the materials are immersed in liquid hydrogen. H. B.

1045. *The Extrusion Defect.* **R. Genders.** (Inst. of Metals, J. 26. pp. 237–245; Disc., 246–259, 1921. Engineering, 112. pp. 487–489, Sept. 30, 1921.)—When a brass rod is extruded from a central die, the last 25 % or 30 % of rod to leave the die contains a characteristic defect peculiar to extruded metal. This consists of a more or less circular core, partially or completely separated from the rest of the metal by a layer of oxide and other foreign matter. The mode of formation of the defect was investigated by the examination of billets extruded to various stages and sectioned. The actual defect appears to consist of the dirty, oxidised skin of the original billet, which is carried inwards by the flow of metal towards the die. Various methods of avoiding the formation of the defect are discussed, amongst which the most hopeful is said to be to avoid relative movement of the receiver and billet. This could be attained by forcing the die into the metal instead of forcing the metal past the die. A series of small-scale experiments, carried out on 60/40 brass, confirmed the correctness of these conclusions. J. L. H.

1046. *Use of the Scleroscope on Light Metal Specimens.* **F. S. Tritton.** (Inst. of Metals, J. 26. pp. 261–270; Disc., 271–280, 1921. Engineering, 112. pp. 492–493, Sept. 30, 1921.)—It is shown that, in testing the hardness of metals by means of the scleroscope, very erroneous results can be obtained if light specimens are used, even if these are rigidly clamped in a vice, in which case a steel with a hardness of 100 may only show a figure of 60. Various experiments on this subject are described, and two forms of support, which enable correct values to be obtained on light specimens, are discussed. In the first of these, the specimen is firmly held in a heavy screw-clamp of the type provided with the old pattern scleroscope, a small piece of pitch being placed underneath the specimen. On screwing up the clamp this pitch is caused to flow slowly, and eventually forms a thin film underneath the object under test. An improved form of clamp is also described. The time taken to mount a specimen—from 5 to 10 minutes—is the chief drawback to this method. In the second case the specimen is smeared with glucose, and is wrung on to a heavy flat-topped steel base. With such an arrangement, perfectly satisfactory results are obtained. The influence of the support was also investigated, and it was found that the use of a soft material, such as lead, caused an appreciable lowering of the scleroscope figure, even when the specimen under test was ½ in. thick. J. L. H.

1047. *Alternating Stress Fatigue.* **H. F. Moore and J. B. Kommers.** (Univ. of Illinois Eng. Experiment Station, Bull. 124. [178 pp.] Oct., 1921. Eng. News-Record, 88. pp. 76–78, Jan. 12, 1922. Chem. and Met. Eng. 25. pp. 1141–1144, Dec. 21, 1921.)—A series of tests, carried out on a machine stated to be a development of the Wöhler apparatus, on a number of carbon and alloy steels, as received and after various heat-treatments. The endurance limits of steel determined in this way appears to be about one-half the ultimate strength, or, expressed in lbs. per sq. in., about 250 times the Brinell number; it does not appear to bear any relationship to any other of the physical properties. J. L. H.

1048. *Simple Filling Apparatus for Definite Inflation of Pilot Balloons.* **R. C. Lane.** (Monthly Weather Rev. 49. pp. 503–506, Sept., 1921.)

1049. *Microchronograph at Royal Observatory, Edinburgh.* **R. A. Sampson.** (Engineering, 112. pp. 500–501, Oct. 7, 1921. Paper read before the British Assoc., Edinburgh, Sept., 1921.)

1050. *Methods for the Production and Measurement of High Vacua.* **S. Dushman.** (Gen. El. Rev. 23. pp. 493–502, June; 605–614, July; 672–673, Aug.; 731–740, Sept.; 847–855, Oct., 1920; 24. pp. 58–68, Jan.; 244–252, March; 436–443, May; 669–680, July; 810–818, Sept., and pp. 890–900, Oct., 1921.)

1051. *The Problems of Physics.* **O. W. Richardson.** (El. Rev. 89. pp. 354–356, Sept. 9, 1921. Address to Sect. A of the British Assoc., Edinburgh, Sept., 1921. Chem. News, 123. pp. 173–178, Sept. 30, 1921. Nature, 108, pp. 372–376, Nov. 17, 1921.)

1052. *The Shape Assumed by a Deformable Body Immersed in a Moving Fluid.* **E. Karrer.** (Frank. Inst., J. 192. pp. 737–756, Dec., 1921.)—Evidence has been assembled to show that any deformable body moving in a fluid or immersed in a moving fluid will assume a shape that is as nearly as is possible "stream-line." L. H. W.

1053. *Effect of Shallow Water on Wave Resistance.* **T. H. Havelock.** (Roy. Soc., Proc. 100. pp. 499–505, Feb. 1, 1922.)

1054. *Vibrations of Bars of Uniform Cross-Section.* **S. P. Timoshenko.** (Phil. Mag. 43. pp. 125–131, Jan., 1922.)—Mathematical.

1055. *Zonal Harmonics of the Second Type; Capacity of Parallel Discs.* **J. W. Nicholson.** (Phil. Mag. 43. pp. 1–19, Jan., 1922.)—The function $Q_n(\mu)$ has received but little study in some of its aspects. In fact, nowhere in the literature of the subject has the writer been able to find the value of the integral

$$\int_{-1}^{1} [Q_n(\mu)]^2 d\mu,$$

which is clearly fundamental. Together with certain other properties of the function, it was found necessary recently to evaluate this integral in connection with the solution of an integral equation arising in the problem of two parallel conducting discs. The capacity of an electrical condenser of this type depends on these properties, and can be expressed without approximation as an integral containing Q functions. A short account of these properties which, though apparently not on record or perhaps unknown, can be obtained in an elementary way, is given in the present note. AUTHOR.

1056. *A System of Space–Time Coordinates.* **J. L. Synge.** (Nature, 108. p. 275, Oct. 27, 1921.)—Methods of measurement employed for the coordination of events—with rigid bars and clocks—are discussed as to their limitations. The only connecting-link across space suitable for the coordination of events is the light-ray. A system of space-time coordinates involving only one metrical quantity—the vibration period of an atom, is defined. Let A be a vibrating atom emitting light-rays, P another particle returning rays from A instantaneously, t' the time of departure of a ray from A, and t'' the time of arrival at A. An event occurring at P at the instant of the arrival of the ray at P has for its coordinates: distance of event from A $= x_1 = \frac{1}{2}(t'' - t')$; time of event $= x_4 = \frac{1}{2}(t'' + t')$. B and C are two particles such that x_1 is constant with respect to time for each of them. Let a ray leave B at time x_4' and return from C at time x_4'', and let C be so situated that $(x_4'' - x_4')$ is constant for all successive rays. Then A, B, and C constitute the frame of coordinates. The example of three of the corners of a rigid rectangular block at rest in a terrestrial laboratory is cited. If an event P occurs

coinciding with the arrival of a ray leaving A at t'_A and returning to A at t''_A and similarly with rays from B and C, its four coordinates are given by: $x_1 = \frac{1}{2}(t''_A - t'_A)$; $x_2 = \frac{1}{2}(t''_B - t'_B)$; $x_3 = \frac{1}{2}(t''_C - t'_C)$; $x_4 = \frac{1}{2}(t''_A + t'_A)$. Though applicable to the most general gravitational fields, the system will give, in the absence of such fields, the same values as those obtained by measurements from three points of a rigid body and a system of clocks.
A. B. C. L.

1057. *Speculations on Relativity.* **A. V. Franklin.** (Roy. Astron. Soc. Canada, J. 15. pp. 276–277, Sept.–Oct., 1921.)—The long-standing disagreement between estimates of the age of the earth from geological deductions and that of the sun from considerations of its output of heat, may, the author thinks, be removed to a great extent. He says that if the relativity hypothesis involves the curvature of heat-rays towards the earth the latter will get a greater proportion of the sun's heat than the solid angle subtended by it at the sun on the rectilinear hypothesis would admit. Hence the sun's loss of heat is much slower than had been assumed, and its probable age must therefore be considerably greater than had been estimated on this basis. W. W. B.

1058. *Gravitational Acceleration of Bismuth: Brush's Results not Confirmed.* **H. H. Potter.** (Phys. Rev. 19. pp. 187–188, Feb., 1922.) —*Gravitational acceleration of bismuth* has been determined by the pendulum method and found to be the same as that for brass to at least one part in 50,000. This result contradicts the claim recently made by Brush that the acceleration for Bi is much less than for Zn. AUTHOR.

1059. *A Geometrical Definition of Einstein's Energy Tension.* **E. Cartan.** (Comptes Rendus, 174. pp. 437–439, Feb. 13, 1922.)—An argument is developed of which the essential feature is the representation as a vector of Einstein's tension of energy. This tension is nil in a space devoid of matter. In the generalisation, the physical state of Einstein's Universe is defined by a vector (of four components) attached to each element of volume (of three dimensions) of the Universe, and satisfying the law of symmetry. The 16 coefficients, which are reduced to 10 by the law of symmetry, can be regarded as the coefficients of a quadratic form of 4 variables, in the same way as the 9 coefficients—reducible to 6—of the vector which defines the tension of an elastic medium can be regarded as the coefficients of a quadratic form of three variables.
A. B. C. L.

1060. *Generalisation of the Notion of Spaces in Torsion and of the Space-Curvature of Riemann.* **E. Cartan.** (Comptes Rendus, 174. pp. 593–595, Feb. 27, 1922.)—A study of the fundamental features of difference between Euclidian space and space in torsion as dealt with in a previous paper [see preceding Abs.]. A. B. C. L.

1061. *On the General Static, Spherically Symmetrical Gravitational Field according to the Einstein Theory.* **C. W. Oseen.** (Ark. f. Mat. Astron. och Fysik, Stockholm, 15. No. 9. pp. 1–6, 1921.)—The author commences by constructing the most general, spherically symmetrical, statical gravitational field on the Einstein theory, using results given by Schwarzschild, Hilbert, Levi-Civita, and Weyl. An expression is obtained which had previously been derived by Gullstrand, who employed another method, and its physical significance is discussed. It is shown that the general Gullstrand solution of the equations $B_{\mu\nu} = 0$, $g = -1$, applied to observations, must lead to exactly the same result as the special Schwarzschild solution. The importance of Gullstrand's work appears to lie in the insistence that a proof of the general theory of relativity must not refer to the objective assertions of the theory, but to observations. This fact has been rendered valid in the discussion of the redward displacement of the solar spectral lines. H. H. Ho.

1062. *The Derivation of Symmetrical Gravitational Fields.* **F. D. Murnaghan.** (Phil. Mag. 43. pp. 19–31, Jan., 1922.)—In a recent publication [Abs. 1000 (1921)] Hill and Jeffery call attention to a symmetrical gravitational field which differs somewhat from the classical one due to Schwarzschild and Einstein. In the usual treatment of this problem a field is said to be symmetrical about a point if the form for $(ds)^2$ is invariant under linear orthogonal transformations of the "Cartesian coordinates" (x_1, x_2, x_2); then a transformation is made to "Polar coordinates" r, θ, ϕ, where $r = \sqrt{(x_1^2 + x_2^2 + x_3^2)}$, etc., and an appeal is made, in choosing a form for $(ds)^2$, to the corresponding form in Euclidean space. Now the essential assumption in the relativity theory of a permanent gravitational field is that the physical space–time continuum is non-Euclidean; the term "Cartesian coordinates" for a non-Euclidean space requires definition, and the equation for r given above assumes an underlying Pythagorean theory that is untenable for non-Euclidean spaces in general. Since the only existing experimental verifications of the relativity gravitational theory are based on the expression for $(ds)^2$ in a permanent symmetrical gravitational field, it is desirable that the assumptions in the mathematical treatment should be clearly stated. In the discussion put forward in the paper, Einstein and Schwarzschild's form as well as others are derived on certain definitely stated assumptions as to the meaning of the term "symmetry," and it is shown that the differential equations of the theory are of a regular character and prove easily integrable, without making any use of the form of the Euclidean element of length on the unit sphere. The paper itself is entirely mathematical. H. H. Ho.

1063. *Deposition of Molecules in Crystals and the Rule of Bravais.* **M. Volmer.** (Phys. Zeits. 22. pp. 646–647, Dec. 1, 1921. Paper read at the Deut. Physikertag, Jena, Sept., 1921.)—The author had criticised the views of Valeton [Abs. 776 (1921)] because they only referred to ionic lattices, and because he believed that there was no reflection of molecules from metallic surfaces. He has since found [Zeits. f. Physik, 7. pp. 1 and 13, 1921; Estermann, dissertation 1921; also Abs. 1967 (1921)] that there is some reflection, and he modifies his views. When a molecule strikes a lattice plane, it does not penetrate into the plane, but continues its movement, and one of three things may happen: (1) it may be volatilised again, for which process not the whole heat of vaporisation is required, but only a portion of that, the heat of adsorption; this re-volatilisation will only affect about 1/12 of the molecules in question in the case of Mg, Cd, Zn; (2) the molecule migrates to the edge of the face and passes over on to another; (3) several molecules aggregate which, impeded in their movements, start the formation of a new plane. In the original face the molecular distribution may be dense or sparse. When dense, the equipotential surfaces will practically be planes, and the migration towards the edge will be rapid. When there are only a few molecules, the equipotential surfaces will be irregular, and the molecular movement, up and down hill, will be slower; hence the rapidity of growth of new planes will be increased. This would account for the rule of Bravais. But the problem cannot so far be treated quantitatively, because we have no data as to diffusion, heat convection, etc. It is yet clear that the large size of a face favours its growth; for with larger faces there is less probability that a molecule striking near the centre of a face will be able to reach the edge, so that new germs will be formed. H. B.

1064. *Chemical Reactions and the Leptonic Structure of Crystals.* **F. Rinne.** (Zeits. f. Metallkunde, 13. pp. 401–406; Disc., 419–424, Sept., 1921.)—A discourse on the connection between crystalline structure and the leptonic structure of electrons, atoms, and molecules [see Abs. 368 (1922)]. The grouping is subject to the rules of iso-dynamostasy. The hydrogen atoms lose their individuality in being coupled to a molecule in which the nucleus and electron of a particular atom can no longer be distinguished. But units remain distinguishable in complexes. It seems possible to expel water molecules from crystals (of brucite, magnesium hydrate, *e.g.*), to extract the silica (of heulandite) and to exchange the bases (of zeolites), without affecting the crystal lattice, which corresponds to the beam-framing of a house, the walls of which may be filled in in various ways. Some photographs of L. Kulazewsky were shown, demonstrating that spheres of tourmaline, etched with hydrofluoric acid or caustic potash, develop peculiar, complex, regular patterns, quite different on the upper and on the lower hemisphere. H. B.

1065. *Crystal Structure of Ammonium Chloroplatinate.* **R. W. G. Wyckoff** and **E. Posnjak.** (Am. Chem. Soc., J. 43. pp. 2292–2309, Nov., 1921.)—The study of the crystal structure of ammonium chloroplatinate, described in this paper, is intended primarily to furnish an illustration of the application of that method of studying the structures of crystals which arises from the use of the theory of space groups [see Abs. 1205 (1921)]. At the same time it serves to indicate the possibilities and, more especially, the present limitations in the study of any but the very simplest crystalline structures.

The experimental method employed is that due to Laue, in which a "spot" diagram is obtained by passing an X-ray beam directly through a slip of crystal. Making use of the assumption that the four hydrogen atoms in the ammonium group are all chemically alike, it is shown that the atoms in the unit cube of ammonium chloroplatinate have the following coordinate positions: ***platinum*** atoms, **4*b***; ***chlorine*** atoms **24*a***, the value of *u* probably lying between **0·22** and **0·24**; ***nitrogen*** atoms **8*e***; ***hydrogen*** atoms **32*a***, the value of u_H being unknown [*a*, *b*, *c*, *e*, etc., refer to particular arrangements described in the text]. The length of the side of this unit cube is $9 \cdot 84^3 \times 10^{-8}$ cm.

The paper concludes with a discussion of the chemical significance of this crystal structure. A. B. W.

1066. *Diffusion and Mobility of Ions of Cobalt and Nickel.* **E[lisabeth] Rona.** (Zeits. phys. Chem. 95. pp. 62–65, July 13, 1920.)—By the method described in Abs. 909 (1919) the author determines the diffusion constants D for cobalt chloride and nickel nitrate in aqueous and acid (HCl or HNO_3) solutions. In aqueous and in diluted acid solutions D decreases with decreasing salt concentration; in the more concentrated acid solutions increasing concentration raises D which, with strong dilution, approaches the value of the divalent ion. The experiments give the mobility values Ni = 48·0 and Co = 47·7; those of Heydweiller were 44·2 and 43·0, and of Feiler 50·4 and 51·0 (method of Hevesy). H. B.

1067. *Theory of the Solid State of Aggregation.* **A. van der Werth.** (Zeits. phys. Chem. 95. pp. 129–138, July 27, 1920.)—The author regrets that thermal data are so little utilised in practice. Noticing, *e.g.*, that malleable alloys remain for a long time red-hot when cast, whilst brittle alloys solidify quickly, he studies the relations between thermal and mechanical data. Both are connected with molecular attraction, and he calculates the work of expansion, i.e., the resistance to rupture, from the thermal expansion, specific heat, and the elastic modulus. The calculations are made for most of the metals, and also for the metalloids graphite, diamond, silicon, iodine, phosphorus, sulphur, selenium. The values deduced from thermal data frequently differ considerably from those obtained from the modulus. H. B.

1068. *Constitution and Configuration of the Atoms.* **E. Kohlweiler.** (Zeits. phys. Chem. 94. pp. 513–541, May 4, 1920.)—Extending his views, which are based upon radio-active decay, the relations of valency and other periodical regularity, and the displacement law of Fajans and Soddy, to all the elements, the author proposes a spacial arrangement of the elements in terraces (or in cascade). On the first level are the elements up to Mn and Fe; Co and Ni then join this terrace on to Cu and to the second terrace of elements up to Ru; Rh joins on to Pd, etc., and the metals of the rare earths form another long link between the latter terrace and the next. All the elements are assumed to have isotopes with the exception of H and He, possibly also of O and N. A table of the isotopes of all the elements up to K is given. Rutherford's splitting-up of nitrogen would be in accordance with these views. H. B.

1069. *Structure of the Atomic Nucleus.* **E. Gehrcke.** (Akad. Wiss. Heidelberg, Ber. [Kl. A.] No. 19, 1919. Chem. Zentrbl. iii. pp. 169–170, 1920.)—An extension of the models of the atoms of Li, Gl, B, C [Abs. 502 (1920)] to the other elements of the periodic system on the assumption that nuclei of the higher elements are repetitions of lower horizontal series. Every element would be a compound of a primal element and electrons, grouped on a systematic plan, and isotopes are possible.

H. B.

1070. *Binuclear Theory of the Atoms and the Periodic System.* **O. Hinsberg.** (J. prakt. Chem. 101. pp. 97–111, Oct., 1920.)—The author distinguishes between nuclear electrons, valency electrons (physically and chemically of secondary importance), and ring electrons; these ring electrons may be reversible (change into valency electrons) or irreversible. Exemplifications are mainly taken from the rare earths. The formation of a molecule is the continuation of the formation of an atom and due to the neutralisation of nuclei which could not complete this process in the atomic state; thus the molecule is an atom of higher order. The study of chemical properties (apart from atomic volume and boiling-point) is quantitatively less important for these theories than that of physical properties, but it gives valuable guidance. H. B.

1071. *Crystal Structure of Alabandite* (*MnS*). **R. W. G. Wyckoff.** (Am. J. Sci. 2. pp. 239–249, Nov., 1921.)—By a combination of a reflection spectrum from a known crystal face with a powder reflection, and employing the general method based upon the theory of space groups, it is shown that the arrangement of the atoms in alabandite is either that of the "sodium chloride grouping" or is a grouping approaching very closely to this arrangement. AUTHOR.

1072. *Frequency of Electrons in the Neon Atom.* **L. S. C. Broughall.** (Phil. Mag. 43. pp. 339–344, Feb., 1922.)—A mathematical paper based on the theories of Bohr and Langmuir for the arrangement and behaviour of electrons within the atom. A. B. W.

1073. *Crystal Structures of Sodium Chlorate and Sodium Bromate.* **R. G. Dickinson** and **E. A. Goodhue.** (Am. Chem. Soc., J. 43. pp. 2045–2055, Sept., 1921.)—The authors have collected a considerable amount of X-ray spectrometer data relating to the crystal structure of sodium chlorate and bromate. In agreement with other observers it has been found that the nature of the crystal surface has a considerable effect both on the absolute and relative intensities of reflection. The ease with which reflections from one face may be mistaken for those from another, and the necessary precautions to avoid this, have been pointed out. It has been found that the atoms in sodium chlorate and sodium bromate are very probably arranged with the symmetry of the space group T^4, all oxygen atoms being equivalent.

Suggestions are made for possible sets of locations of the atoms in the elementary structure. In these arrangements the structure for chlorate and bromate are only slightly different. A. B. W.

1074. *Application of Anode Rays to the Investigation of Isotopes.* **G. P. Thomson.** (Phil. Mag. 42. pp. 857–867, Nov., 1921.)—In a previous paper the author has shown that anode rays are susceptible to the ordinary method of positive-ray analysis, and that their impact affects a photographic plate [see Abs. 291 (1921)]. Since the anode rays consist almost entirely of charged metallic atoms, it follows that they can be used to investigate the number and proportions of the isotopes of metals, provided that the resolving power of the analysing apparatus be sufficient. In the experiments now described the method of analysis was the ordinary parabolic one.

Photographs have been obtained for anode rays showing parabolas corresponding to singly-charged atoms of the following metals: Lithium, beryllium, sodium, potassium, calcium, and strontium. Lithium is a mixture of isotopes of atomic weights 6 and 7. The proportions in which these appear in the rays are not constant, there being a tendency for the line at 6 to be sometimes considerably stronger than would be expected from the atomic weight. Beryllium is apparently simple, atomic weight 9. If there is an isotope at 10 or 11, it is present in extremely small proportion. The remaining elements could not be resolved with the apparatus used, but calcium must consist of atoms of weight equal to those of either potassium or argon, i.e., a so-called "isobar." No trace was found of doubly-charged metallic atoms, or of atoms with a negative charge. It seems probable that the mechanism of the anode rays is more analogous to sputtering than to electrolysis. A. B. W.

1075. *Rutherford's Splitting-up of the Nitrogen Nucleus.* **W. Lenz.** (Naturwiss, 8. pp. 181–186, March 5, 1920.)—Viewed from the standpoint of the relativity theory, the stability of the helium nucleus is intelligible, and the instability of nitrogen appears explicable. H. B.

1076. *Electrostatic Lattice Potentials.* **M. Born.** (Zeits. f. Physik, 7. 2. pp. 124–140, 1921.)—Röntgen-ray studies of crystal structure indicate that there are a few predominating lattice types. The rocksalt lattice in particular is very frequent, and may therefore be supposed to be distinguished by geometric or dynamic properties and by a close packing and a minimum of energy of cohesion. In rocksalt positive Na ions are everywhere surrounded by negative Cl ions, and the electrostatic forces tend to bring the ions closer to one another until the attraction is counterbalanced by the repulsion due to the fine structure of the ions themselves. This does not prove, however, that the cohesion energy of rocksalt is smaller than that of other lattices. The problem is very complex, and cannot be solved without making several assumptions, even if limited to the task of determining how a finite length of a cubical space lattice can so be provided with the same number of positive and negative charges of the same amount that the electrostatic energy of the system be a minimum. The energy of the repelling forces is disregarded; all the atoms are regarded as rigid spheres of the same size, and every point of the lattice is supposed to be occupied. The lattice is considered to be indefinitely extended, and the charge distribution to be periodical. Even with these assumptions the mathematical problem is only partly solved. The author makes use of the convergent series of lattice potentials of P. P. Ewald. H. B.

1077. *Thermodynamics of Crystal Lattices.* **M. Born.** (Zeits. f. Physik, 7. 4 and 5. pp. 217–248, 1921.)—Having in his "Dynamik der Kristallgitter" traced the elastic and piezoelectric constants, etc., back to atomic forces, the author attempts to do the same for the thermal quantities. He proceeds on lines similar to those of Debye, but he does not disregard Hooke's law like the former, who considers thermal motions as vibrations of an ordinary oscillator. The author applies a thesis of his and Brody (*ibid.*, 6. p. 140, 1921) of the quantum theory according to which the thermal parameters have different orders of magnitude with respect to the degree to which the deviations of the atomic forces from Hooke's law have to be considered. Assuming central forces between the particles of a lattice, all properties of crystals, it is found, as well as the mutual relations between mechanical, thermal and electric changes of state can qualitatively be expressed. The quantitative relation is not extended beyond the quantum theory of the simple Planck oscillator, and the quantitative dependence of the dielectric, elastic, piezoelectric constants is so far excluded; they change little with temperature, however. The temperature changes of heat capacity, thermal expansion, and pyro-electricity agree qualitatively with experiments; in how far quantitatively remains to be seen. It would particularly be desirable to ascertain whether near absolute zero the T^4 law changes into a T^2 law for dilatation and pyro-electricity (Debye). H. B.

1078. *The Crystal Lattice of Magnesium Oxide.* **W. Gerlach** and **O. Pauli.** (Zeits. f. Physik, 7. 2. pp. 116–123, 1921.)—Experiments made after Debye and Scherrer, full particulars to be published in Niggli's *Zeitschrift für Kristallographie.* The magnesia was fused and ground to very fine or coarser powders, or prepared by calcination of $MgCO_3$; the powdering should not be too fine so as to leave the weak lines distinct. Photometric measurements of the photograms are not made, because the intensity of the lines depends not only on structure, but also on absorption and what may be called reflection. The divalency of the MgO ions is shown by the fact that the line (111) is never visible. The regular MgO crystals form a face-centred cubic lattice of length of side $a = 4 \cdot 22$ Å.U. H. B.

1079. *Electronic Affinity and Lattice Theory.* **M. Born** and **W. Gerlach.** (Zeits. f. Physik, 5. 5 and 6. pp. 433–441, 1921.)—From the iodine spectrum of Steubing, Franck has deduced the electronic affinity of the iodine atom $E_y = 59 \cdot 2$ kg. cals. Born and Fajans [Abs. 641 (1920)] had found 80 cals. The interpretation of Steubing's results by Fajans being apparently correct, the authors consider that the lattice-theory values must be questioned and the theory be modified. Though the difference of 20 cals. must not be expressed as percentage of the electronic affinity, it is very large, and recalculation of the values per KI and NaI leaves a discrepancy of 12 %. Similar discrepancies arise when the electronic affinities of the divalent atoms of sulphur and oxygen are calculated with the aid of the measurements, by Madelung and Fuchs, of the compressibilities of some crystals of their compounds [Abs. 1653 (1921)]. The crystals considered are blende and galena and periclase (MgO) and CaO. It is maintained that the attractive force of the lattice theory on the extreme polar compounds is of an electrostatic nature. The nature of the repulsive force is little investigated, and it is suggested that the potential energy is only approximately expressed by br^{-n}. H. B.

1080. *Stability Relations of Atom Nuclei.* **W. D. Harkins** and **S. L. Madorsky.** (Phys. Rev. 19. pp. 135–156, Feb., 1922.)—*Graphical Study of the Electrical Properties of Atomic Nuclei and their Relation to Stability.*—The properties considered are: P the number of positive electrons in the nucleus, which is taken to be numerically equal to the atomic weight, M the net positive charge which is equal to the atomic number, N the number of negative electrons which is equal to (P − M), $[(N/P) - \frac{1}{2}]$ the excess of the relative negativeness N/P over the minimum $\frac{1}{2}$, and n the isotopic number which is equal to (P − 2M) and also to (N − M). The relations between each of these five quantities and each of the others for the various atomic nuclei are shown in ten two-dimensional plots which clearly bring out the stability relations and are of particular interest because of the limited region in each plot where atoms are found. Except in the case of hydrogen and of the helium isotope P = 3, N/P is never less than $\frac{1}{2}$ and M/P is never greater than $\frac{1}{2}$; in fact, for 85 % of the atoms composing the crust of the earth, both these ratios are equal to $\frac{1}{2}$ and n is equal to zero. As the atomic number, that is the net positive charge, increases, the *relative negativeness necessary to stability* increases above $\frac{1}{2}$, more and more; that is, as α-particles are added extra cementing electrons are required to overcome the increasing mutual repulsion of the positive units of the nucleus. An α-ray transformation does not change n but increases N/P, while a β-ray change decreases n by 2 units and also decreases N/P; we therefore find that in each group of isotopes, the ones with larger values of N/P show greater β-ray and less α-ray instability. Stability considerations also help to explain the fact that the *number of isotopes* is on the whole smaller for the lighter atoms. The curves bring out other interesting relations. The number of isotopes is larger for even than for odd-numbered elements, especially for $M \gtreqless 30$. Also for most atoms, M, n and P are either all even or all odd, but N is usually even. The curve for the *frequency of occurrence of atoms* as a function of n shows periodic maxima four units apart, while as a function of M (or of N) the periodic maxima are two units apart. These regularities make it possible to predict the existence of the more abundant isotopes of elements whose mean atomic weights are accurately known; for instance, in the cases of lithium and boron predictions made in 1920 were later verified by Aston and by Dempster. AUTHORS.

1081. *Radii of Alkali-Metal Atoms and of their Ions.* **R. Lorenz.** (Zeits. f. Physik, 6. 4. pp. 271–275, 1921.)—The meaning of space-filling may be misunderstood. If we imagine the mol-volume of the shape of a cube and divide the volume by the number of molecules, the space is divided into elementary cubes. The volume of a sphere inscribed would be to the volume of the cube as 0·52 : 1, and this ratio is the space-filling ratio ψ_0 of the author [Abs. 212 (1921)]. But the closest tetrahedral packing would yield $\psi_0 = 0{\cdot}74$, van der Waals' equation would give 0·25 for absolute zero, and if the elementary cube were wholly packed with cubes (not with spheres), ψ_0 would be 1. In the new table of the atomic radii of the alkali metals the values are given for these various ψ_0, and the average ψ, 0·52 (which is the mean between 0·74 and 0·25), is found to agree also with the value deduced by G. Meyer and Wogau, after Stokes-Einstein, from the diffusion of the alkali metals in mercury. The author further gives, in Table II, the ionic radii (deduced by various investigators by various methods) which indicate not the true ionic radii or radii of the electrons, but the spaces "claimed," though not necessarily filled, by the ions. H. B.

1082. *Rate of Ascent of Liquids through Granular Media.* **F. E. Hackett.** (Faraday Soc., Trans. 17. pp. 260–267, Feb., 1922.)—The ascent of liquids in sands which takes place in 2 to 24 hours, according to the viscosity of the liquid, satisfies the laws of capillary flow for the tube-like spaces between the grains. The ascent may continue for over a year, and the final heights attained may be two to three times the height reached in the first stage. This second stage satisfies an equation similar to that for capillary flow, but the constants deduced are not in agreement with the theory of capillary flow. AUTHOR.

1083. *Thickness of Stratified Films.* **P. V. Wells.** (Ann. de Physique, 16. pp. 69–110, Sept.–Oct., 1921.)—This investigation of stratified films shows that the law of multiple thicknesses of J. Perrin is verified, in that the clumps of these films are formed by the superposition, in any number whatsoever, of identical elementary leaflets or flakes. This elementary leaflet is of the same thickness as the black spot, namely, about 4·4 $m\mu$. (millimicrons) for a soap film, which value is distinctly lower than those given by Reinold and Rucker, and Johonnott for the black spot. The elementary leaflet has the same thickness in the case of stratified films of potassium oleate and glycerine. It is very probable that the black spot is a dimolecular film, and that the elementary leaflet is also a dimolecular layer. This hypothesis is in agreement with the results of measurements of mono-molecular layers of oil on water. L. H. W.

1084. *The Law of Viscosity Change with Temperature.* **H. Vogel.** (Phys. Zeits. 22. pp. 645–646, Dec. 1, 1921. Paper read at the Deut. Physikertag, Jena, Sept., 1921.)—By introducing the symbols η_∞ as viscosity limit for the temperature $t = \alpha$, at which the viscosity η becomes ∞ or the fluidity $1/\eta = 0$, and the temperature t_1 for which the viscosity becomes $\eta = 1$, the author obtains the formula : $\eta_t = \eta_\infty{}^{(t-t_1)/(t-t_\infty)}$. In this formula η may be replaced by the " factor of toughness " Z used in technics. The formula agrees very well with experimental data for all liquids, water, mercury, oils, etc., all over the liquid range, and might be applicable to molecular considerations. For the present the formulæ are especially recommended for oil testing, the whole temperature curve being determinable from three viscosity measurements.—In reply to **Schulz,** the author stated that he had not studied undercooled liquids such as glasses. H. B.

1085. *Viscosity of Mercury.* **J. E. P. Wagstaff.** (Cambridge Phil. Soc., Proc. 21. pp. 11–13, Feb., 1922.)—Describes a method applicable to liquid conductors of electricity. The experiment with mercury is described, but the method has also been used for liquid electrolytes. The liquid flows through a capillary tube from one vessel into another, in which are two Pt wires at different depths. The time interval between the establishment of contact with the wires gives, with the known volume of liquid corresponding to the difference of level thus measured, the coefficient of viscosity, using the ordinary formula. J. W. T. W.

1086. *Measurements of Sky-Brightness and Daylight Illumination.* **H. H. Kimball.** (Am. Illum. Eng. Soc., Trans. 16. pp. 255–275; Disc., 275–283, Oct., 1921.)—Measurements of sky-brightness, with varying conditions in respect to presence of clouds, were made with a Sharp-Millar photometer. Results are assembled on a series of charts, the sky being divided into 10° zones concentric round the zenith, or about selected points on the horizon, and the brightness of these zones determined for typical sky conditions. It is shown that by the aid of such charts the resultant daylight illumination on specified vertical or horizontal surfaces may be calculated, and methods of taking into account the shading effect of buildings, etc., are suggested. It is hoped that such data will prove useful in determining the intensity of daylight derived from an average sky. J. S. D.

1087. *The Air and its Ways.* **N. Shaw.** (Nature, 107. pp. 653–655, July 21, 1921. Rede Lecture, Cambridge, June, 1921.)—The general problem of the science of meteorology is to relate our knowledge of the atmosphere, about the lowest 20 km. of which many facts are known by observation, to the laboratory laws of physics, in particular those of energy. The atmosphere may be correctly regarded as a moist-air engine, and its ways usefully considered from this standpoint. The boiler is found in the temperature distribution with the equatorial warmth; the condenser in the upper air particularly in the stratosphere which effectively disposes of heat by radiating it into space, and also, but secondarily, in the cooling surfaces provided by the high lands of Arctic and Antarctic regions, and by snow-clad mountains; the flywheel in the general and local circulation of the atmosphere. An indicator diagram has been arrived at in the form of an entropy–temperature diagram, by which changes accompanying the ascent and subsequent descent of a sample of air may be traced. This diagram shows that the moist air of the equatorial regions, working between the earth's surface and the stratosphere cannot be expected to produce more than a " brake-horse-power efficiency of 25 %." In other latitudes the figure is less. Nevertheless the available energy is quite adequate for the development and maintenance of observed atmospheric phenomena. M. A. G.

1088. *True Mean Temperature.* **C. E. P. Brooks.** (Monthly Weather Rev. 49. pp. 226–229, April, 1921.)—The complexity of the question of obtaining the true mean temperature led the late A. Buchan to look favourably on the mean daily extremes, (maximum plus minimum)/2, as an expression of the mean temperature. This view has become traditional among English-speaking races, but it has two very grave objections, and it is not adopted by continental or South American meteorologists. The objections are stated. The means of observations taken at 7 a.m., 1 or 2 p.m., and 9 p.m., giving the evening observation double weight, are recommended for general use. L. H. W.

1089. *Secular Variations of Climate.* **J. Paraskévopoulos.** (Monthly Weather Rev. 49. pp. 230–231, April, 1921.)—After a brief discussion of the secular variations of the climate of the earth, the following theories proposed for the explanation of these variations are described. None of these theories is sufficient to account for the known variations of climate, and some require dynamical conditions which are not in accord with celestial mechanics. These theories are:

1. The effect of the temperature of the interior of the earth.
2. Emanations of radio-active substances in the earth's crust.
3. Variations of solar energy according to Russell's theory of stellar evolution.
4. Variations of the inclination of the earth's axis (precessional motion and variations of latitude).
5. The " pendulation " theory.
6. Variations in the carbon dioxide content of the air.
7. Volcanic action; dislocation of parts of the earth's crust; distribution of sea and land.
8. Cosmic causes.

It is concluded that no single theory is likely to be the right one, but that the factors represented by several theories combine to give the known secular variations of climate. AUTHOR.

1090. *Variability of Mean Annual Temperature over North America and Europe during the Ten Years* 1900–1909. **N. A. Comissopulos** and

J. Wadsworth. (Roy. Meteorolog. Soc., J. 47. pp. 283–285; Disc., 285–286, Oct., 1921.)—The standard deviation (S.D.) from the mean of the mean annual temperatures during the period in question is adopted as a measure of the variability. The object in view is to ascertain whether there is a definite relationship between variability and geographical position. Two courses are followed: firstly, that of statistical correlation, and secondly, that of charting the standard deviations against the corresponding stations and drawing isopleths. The results for Europe and North America are similar. An apparently significant positive correlation is found between S.D. and latitude. Further investigation shows a significant negative correlation between S.D. and mean annual temperature. Proceeding to partial correlation, however, it is found that the connection with mean annual temperature alone is significant, that with latitude arising solely through the high correlation between latitude and mean annual temperature. The general features exhibited by the charts are high values of S.D. in the north, decreasing both southwards and towards the coasts. M. A. G.

1091. *Dynamics of Wind.* **H. Jeffreys.** (Roy. Meteorolog. Soc., J. 48. pp. 29–46; Disc., 46–47, Jan., 1922.)—Gives a dynamical classification of wind in which the three main groups are: "Eulerian," in which the horizontal pressure gradient produces acceleration of the air over the ground; it is shown that all cyclostrophic winds belong to this group. "Geostrophic," in which the pressure gradient just overcomes the influence of the earth's rotation, which tends to deviate the wind from the isobars. The general circulation, cyclones of middle latitudes, and all winds of widespread effect are approximately geostrophic. "Antitriptic," in which the pressure gradient is expended in overcoming friction; land and sea breezes and mountain and valley winds in the greater part belong to this group.

Theories are given to account for the annual pressure variation over Asia, land and sea breezes, and mountain and valley winds. A. W. L.

1092. *Rainfall Maps of Latin America.* **E. Van Cleef.** (Monthly Weather Rev. 49. pp. 537–542, Oct., 1921.)

1093. *Correction to L. Geiger's Determination of Earthquake "Epicentres from Arrival Times."* **F. Burmeister.** (Phys. Zeits. 23. p. 45, Jan. 15, 1922.)—The method proposed by Geiger [see Abs. 1575 (1910)] for the determination of the epicentres of earthquakes from the times of arrival at various places has been employed by the present author. The results obtained show Geiger's formula to require a correction, which latter is evaluated in the present paper. H. H. Ho.

1094. *The Age of the Earth.* **J. Joly.** (Nature, 109. pp. 480–485, April 15, 1922. Discourse delivered at the Roy. Inst., Feb. 24, 1922.)

1095. *Atlantic Temperatures.* **E. Le Danois.** (Comptes Rendus, 173. pp. 923–925, Nov. 14, 1921.)—The paper is a summary of the temperature observations made in the recent traverses of La Tanche along the French coasts between Spain and Ireland. It was found that the continental shelf at the entrance to the Channel corresponds to the banks of

Newfoundland on the American coast, in the sense that it is also the meeting-place of hot and cold waters. The phenomena are, however, quite independent, and that on the other side of the Atlantic is the more intense. W. A. R.

1096. *Depressions Observed in the Values of Solar Radiation Intensity.* **L. Gorczyński.** (Monthly Weather Rev. 49. pp. 606–608, Nov., 1921.) —Radiation measurements have been made at Warsaw since 1900 with a Michelson actinometer and Ångström pyrheliometer. During this period two marked depressions in the solar radiation intensity have been noted, one lasting continuously from Nov. 1902 to Feb. 1904, and the other from July 1912 to Jan. 1913. Data for Warsaw illustrating these are produced in the form of departures of the individual monthly maxima of intensity from the mean for the whole period. They show that the negative departures during the periods referred to exceeded 10 %. These depressions were world-wide, having been noted at other observatories, and are attributed to the effect of volcanic dust following eruptions of Mount Pelée (Martinique) and Mount Katmai (Alaska) respectively. M. A. G.

1097. *Latitude Determination with a Meridian Instrument, a Mercury Trough, and a Plane Mirror, with Application to Nice Observatory.* **R. Baillaud.** (Bull. Astronomique, 1. No. 5. pp. 283–292, 1921.)—Instead of Cornu's device of two mirrors at right angles, dovetailed together, the author proposes a plane mirror with parallel faces, one of them silvered over one half. It is not necessary that the mirror should be placed at an angle of 45°, nor that the observing instrument should be horizontal. It is only required that one should be able to see the image of the cross-wires as well as the star. The faces of the mirror should be exactly parallel to ensure that the same reading of the declination screw should give both zenith and nadir.

It is not necessary for the mirror to have its faces parallel to obtain variations of latitude, but only for absolute latitude. The addition of a mercury trough enables latitude observations to be made, but only of stars some distance from the zenith, when refraction cannot be ignored, and when its value is a little uncertain. The author gives details of his determination of the latitude of Nice observatory, $43^\circ\ 43'\ 19''\cdot 13$. Perrotin's value in 1884 was $43^\circ\ 43'\ 16''\cdot 9$. The difference of $2''\cdot 2$ is principally due to the fact that one instrument is 65 m. north of the other. The real accordance is to $\frac{1}{5}$ of a second of arc. W. W. B.

1098. *Daily Variation in Clock Corrections.* **W. S. Eichelberger** and **H. R. Morgan.** (Astron. J. 34. pp. 15–17, Jan. 31, 1922.)—The authors set out to obtain confirmation or otherwise of a result given by Zimmer [Abs. 486 (1922)] at Cordoba, and said to be confirmed elsewhere, that clock corrections determined at or near sunset were uniformly larger by 4 or 5 hundredths of a second than corresponding ones at or near sunrise. The data they choose are from U.S. Naval Observatory observations with 9-inch transit circle 1903 to 1911. From 1909 July to 1911 April two groups, each of 6 clock stars, with mean R.A. about 6 h. and 18 h. respectively, were observed whenever possible. The result of 2000 observations goes to show that there is no change during the night, that twilight observations give a clock correction about one-hundredth of a second larger, and that daylight observations give a distinctly larger correction, especially in the afternoon. For this reason they exclude the daylight observations from their discussion. They give in tabular form the data obtained in the eight winters of the catalogue, arranged in years and also in seasons. The ultimate maximum difference between A.M. and P.M. observations comes out at less than a hundredth of a second, after eliminating periodic errors from the R.A.'s and daily variations in instrumental constants and keeping the clocks under constant pressure and temperature. W. W. B.

1099. *Existence Theorem for Certain Periodic Orbits in Restricted Problems of Three Bodies.* **W. M. H. Greaves.** (Roy. Astron. Soc., M.N. 82. pp. 139–149, Jan., 1922.)—This is an analytical proof of the existence of periodic orbits. The solution differs from one given in Moulton's "Periodic Orbits." W. W. B.

1100. *Variation of Wave-lengths of Telluric Lines.* **A. Perot.** (Comptes Rendus, 174. pp. 215–217, Jan. 23, 1922.)—In a previous paper [Abs. 991 (1915)] the author concluded as a result of measures of the telluric lines of group B in 1914 June, that the wave-length increased in proportion to the sine of the sun's altitude, so that $d\lambda/\lambda = k \sin \theta$. The value then found for k was 1×10^{-5}. Four fresh series of observations taken in the period Oct. 1920 to Sept. 1921 yield apparently similar results, but the ratio is not the same. The significant part of k, which was 1 in 1914, comes out 1·8 in Oct.–Nov. 1920, 0·98 in July 1921, and 1·3 in July–Aug. 1921, rising to 2·3 for the fourth set, Sept. 1921. The author suggests that meteorological conditions in the upper air may be responsible. W. W. B.

1101. *Accidental Errors of Argelander's Method.* **P. M. Ryves.** (Roy. Astron. Soc., M.N. 82. pp. 78–84, Dec., 1921.)—From the day after Denning's discovery of Nova Cygni III until it became invisible to the naked eye the author kept it under observation. He found the data obtained sufficiently refined to show up small differences between the Harvard catalogues, and so determined to use them for an inquiry into the nature and magnitude of the accidental errors affecting the method of observation. He gives reasons for ignoring many of the usual disturbing factors for this series of measures. The most surprising result he considers to be the inference that although, as might be expected, there is a larger probable error when the difference of magnitude is large than when it is small, yet when it is exceedingly small the error increases again. This suggests some other factor, and a discussion as to its probable nature is given, pointing to a systematic rather than an accidental cause. W. W. B.

1102. *Invisible Sun-Spots.* **G. E. Hale.** (Roy. Astron. Soc., M.N. 82. pp. 168–169, Jan., 1922.)—Sun-spots have been found to show a strong tendency to occur in pairs with opposite magnetic polarity. Nearly all single spots are followed or preceded by streams of Ca flocculi. The author thought that an incipient spot might be found in the floccular region, and by special adaptation of a Nicol prism with a half-wave plate Zeeman-effects were found in several cases. In some of these, where an "invisible" member of a bipolar spot was thus located, a small spot afterwards appeared. Similarly the effect noted persisted for some time after a spot had disappeared. He hopes to continue the work, and also to search for cases where neither of the spots of the pair is visible. He thinks Ca flocculi the best guide, but that probably faculæ would do if they could be seen easily near the centre of the sun's disc. He hints at an explanation, such as a semicircular vortex ring, but admits great difficulties, such as the complicated set of mixed polarities in the sun-spot of May 1921. W. W. B.

1103. *Solar Constant, Sun-Spots, and Solar Activity.* **A. Angström.** (Astrophys. J. 55. pp. 24–29, Jan., 1922.)

1104. *The Perihelion Motion of Mercury.* **E. Grossmann.** (Astron. Nachr. No. 5115. Zeits. f. Physik, 5. 4. pp. 280–284, 1921. Nature, 108. pp. 164–165, Sept. 29, 1921.—Abstract.)—After consideration of the various corrections required, the author arrives at the values + 29″ and + 38″ for the divergence between observation and theory in the perihelion motion of Mercury. The value 43″ demanded by the Einstein formula is thus not reached. L. H. W.

1105. *Perturbations of Eros.* **A. C. D. Crommelin.** (Observatory, 45. pp. 25–26, Jan., 1922.)—Witt's preliminary investigation of the earth perturbations of Eros from 1893 to 1912, omitted perturbations by Mercury, Uranus, and Neptune. E. Noteboom continues the work, including 1914 observations, using a special solar ephemeris with 8-figure logarithms, and including the three omitted planets. His solution represents all the normal places since 1898 within 2″·9, and those for 1893, 1894, and 1896 within 4″·6 (Eros was discovered in 1898). Only two observations are available for the 1903 opposition. The investigation is a very refined mode of obtaining the solar parallax. Noteboom's result is 8·799 ± 0·001, which is almost identical with Witt's corrected value. Eros should be well observed at every opposition, and will be well placed in the northern hemisphere in autumn 1923. W. W. B.

1106. *New Measurements of Stellar Radiation.* **W. W. Coblentz.** (Astrophys. J. 55. pp. 20–23, Jan., 1922.)

1107. *Photographic Effective Wave-length as the Colour Equivalent of Stars.* **B. Lindblad.** (Ark. f. Mat. Astron. och Fysik, Stockholm, 13. No. 26. pp. 1–75, 1919.)—An instrument of the refractor type of which the achromatisation fulfils certain conditions may be used with advantage for determining the effective wave-lengths by means of objective gratings without necessitating too great a correction for the size of the image. This correction differs for various colour types and must be experimentally established for each particular instrumental arrangement. The diameter of the central image is a suitable correction parameter. Corrections must also be made for the orientation on the plate and for the zenithal distance. This latter correction also varies for different effective wave-lengths. The wave-length reduced to a normal size of image shows a close relation to the spectral class as determined from the lines in the spectrum. For stars of great absolute brightness this agreement is noticeably better the more accurate the spectral classification. The classifications here used are those in the Revised Harvard Photometry, those of

Maury, and of Adams and Joy. The effective wave-lengths determined with different instruments agree fairly well, but the amplitude variation may differ for various colour-types. The total amplitude variation appears always to be greatest with reflectors. The effective wave-length is a colour equivalent and therefore in close relation to the colour index as well as to the effective temperature determined spectrophotometrically. Comparison with the visual colour estimates according to Potsdam shows a fairly large dispersion in the effective wave-lengths and reveals the previously known inequalities in the Potsdam scale. Comparison with Osthoff's colours shows very close agreement between the two colour equivalents. Finally, the connection between spectral type and colour has been closely investigated, with the result that the colour in a given spectral type is shown to be related to the absolute magnitude. It thus appears possible, by determining spectrum and colour, to separate the "giants" and "dwarfs" and so to determine by a new method the parallaxes of stars of the later spectral types. E. F.

1108. *The Motion of Stars of Various Spectral Types.* **C. V. L. Charlier** and **W. Gyllenberg.** (Ark. f. Mat. Astron. och Fysik, Stockholm, 14. No. 18. pp. 1–28, 1920.)—A statistical investigation of the motions of stars of the various spectral types on the basis of their proper motions. The paper gives data for calculating the velocity ellipsoid, but consists mainly of tables and mathematical formulæ and cannot be usefully condensed. E. F.

1109. *Dynamical Equilibrium of the Stellar System.* **A. S. Eddington.** (Astron. Nachr. Centenary No. Nature, 108. p. 480, Dec. 8., 1921.—Abstract.)—The author takes a further step beyond his previous spherical approximate system [see Abs. 827 (1915)], and considers an oblate system. He presumes that a rotating system which has settled down to a steady state must be oblate. Dividing into two identically equal systems and reversing the direction of rotation of one of them, he obtains a non-spherical system, in equilibrium, with no rotation as a whole but with preferential motion in a transverse direction. He gives a detailed solution for a homogeneous spheroid, strictly analogous to Maclaurin's hydrodynamical spheroid. This does not exclude the possibility of non-homogeneous solutions. He points out that the stellar system has very likely not yet reached a steady state, but may be collapsing quite rapidly towards it. He looks to accumulating data in regard to stellar masses and velocities, in conjunction with the principle that in dynamical equilibrium the total kinetic energy is half the exhaustion of potential energy, to provide possibly a definite decision. W. W. B.

1110. *Graduated Wedge for Stellar Classification and Parallax Work.* **W. J. S. Lockyer.** (Roy. Astron. Soc., M.N. 82. pp. 226–232, Jan., 1922.)—For these investigations it is necessary to be able to determine the relative intensity of spectral lines. Not having a stereo-comparator, the author determined to employ a wedge. Preliminary tests with a neutral-tinted wedge, made like an echelon grating by superposing strips of evenly exposed Kodak films of graduated size, were promising, so a more refined wedge was obtained. Details are given of the method of testing and employing the wedges, two being used of different densities, and a table of comparison of the results obtained with each by two different observers, on a set of lines from H_β to H_ϵ, showing a fairly consistent personal equation between them. The probable errors are computed both for the lines and for the wedges, and a test of the method was made on certain stars. There is a satisfactory ratio between the results obtained from the two wedges. The author considers the probable error of a resulting parallax will be of the order of 25 % for F-type stars, and 50 % for K-type stars, but these are considerably reduced by increasing the number of measures made, and the number of lines employed for deducing the magnitude of a star. W. W. B.

1111. *Orbit of Spectroscopic Binary Boss 5442.* **R. K. Young.** (Roy. Astron. Soc. Canada, J. 16. pp. 12–14, Jan., 1922.)—This star (position for 1900, 21 h. 4 m. + 29°·48′), of 5·6 mag. and type A0, was found to be a binary in 1918. The type should rather be classed B8. Between July 1920 and Aug. 1921, 49 spectrograms were obtained. The period of 3·3137 days seems to be undoubted, but there is probably a secondary component which affects the fit of the observations. A curve is given showing the difference of the fit at different epochs. It may be that, like that of 12 Lacertæ, the amplitude is variable, but it will be very difficult to prove this on account of the comparatively long period of over three days. W. W. B.

1112. *Origin of Binary Stars.* **J. H. Jeans.** (Scientia. Nature, 109. p. 89, Jan. 19, 1922.—Abstract.)—Since half the stars are probably binaries, they cannot be regarded as abnormal. The author considers three possible origins: (1) fission of a single mass, (2) formation of adjacent nuclei in the original nebula, sufficiently close to be held together gravitationally, and (3) capture arising from the approach of two stars originally independent. The last suggestion cannot be of wide application. He estimates that in a universe of a thousand million stars there would only be ten thousand captures in a thousand million years. The first suggestion is plausible in the case of very close spectroscopic binaries, but very improbable in the case of wide pairs. For these he considers the second explanation more probable, but suggests no reason why nebular condensations should have such a tendency to occur in pairs. He notes that very scattered groups such as the Taurus and Ursa Major clusters may be explained in the same way as arising from condensations in a primitive nebula, when the mutual distances were too great for any gravitational effect. W. W. B.

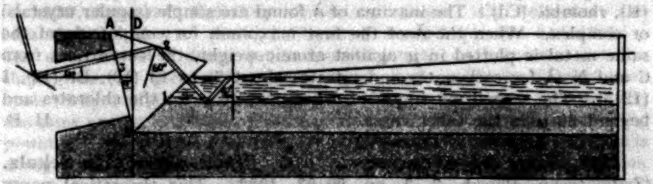
1113. *Motions of the Stars in a Kapteyn Universe.* **J. H. Jeans.** (Roy. Astron. Soc., M.N. 82. pp. 122–132, Jan., 1922.)—Kapteyn's investigation of the distribution of stars in space [Abs. 1392 (1920)] points to an arrangement in spheroidal shells, similar and similarly situated, each of constant density, oblate in the galactic plane and centred near the sun. In a dynamical investigation of such a system he assumed the stars to be in a dynamically steady state, but the author of the present paper criticises a second assumption, that the law of distribution along the shortest axis, i.e. towards the pole of the galaxy, is Maxwell's law for the distribution of molecular velocities of a gas in isothermal equilibrium. He considers this assumption unnecessary. Gravitation effects on any star may be divided into (1) forces from adjacent stars, and (2) forces from the field of the universe. The first, which are in comparison small, can be studied best when the second set has produced a steady state, and thus been reduced to zero, after which the first set can have its effect until it also produces a steady state. But star-streaming clearly indicates that the final steady state has not been reached. The author thinks it possible, however, that the intermediate stage may have been reached in which only the effect of neighbouring stars is left to operate.

To test for a single "shell" of Kapteyn's series, the author considers quantitatively the B stars, assuming Charlier's distribution, and then extends it generally to the whole. He obtains a new solution for the stellar density, which fits Kapteyn's observational material well enough for the outer shells of stars, but less closely near the sun. He finds that the new position of the centre of the galaxy comes outside the system of the B stars according to Charlier, and suggests that perhaps the B stars are a moving cluster independent of the galactic system. [See next Abstract.] W. W. B.

1114. *Dynamics of Moving Clusters.* **J. H. Jeans.** (Roy. Astron. Soc., M.N. 82. pp. 132–139, Jan., 1922.)—In a previous paper [Abs. 1117 (1916)] the author suggested that a moving cluster ought to assume a flattened shape in consequence of encounters with other showers of stars. Rasmuson has recently tested this, and finds that some (*e.g.* Ursa Major cluster and that in Perseus) do show this flattening, but that others (*e.g.* Scorpio-Centaurus cluster) show the opposite effect. The author had supposed the forces acting on a cluster star to be divided into three parts, according as they are due to (1) the other stars of the cluster, (2) stars encountered by the cluster, or (3) the rest of the universe. The predicted flattening was derived from the second of these, the first being neglected and the third assumed only to affect the motion of the cluster as a whole and not its shape. The present paper seeks to determine the effect of fully considering the other two classes. He finds that there will be in both classes a tendency to flattening parallel to the galactic plane. Rasmuson's figures for certain clusters are shown to be in fair accordance with those expected by the author. The B-type stars [see preceding Abs.] conform closely to the arrangement to be expected on the hypothesis that they are a cluster moving with a low velocity, and the expected flattening is in fair accord with that found by Charlier. An additional point in favour of the suggestion that these stars are an independent cluster is the fact that they do not seem to conform to either of the two star-streams. Investigating the probable motion of this or any similar cluster, the author finds that there must be comparatively rapid dissipation of the outer shells. All clusters except globular ones are confined to the neighbourhood of the galactic plane, and it will be found that clusters outside the dense central regions should spread rapidly in planes parallel to that of the galaxy. The whole system may have been formed by a collection of moving clusters, of which a few only now remain as separate entities, the rest making up the galactic system. The author mentions in support of this hypothesis the distribution of the orbits of binary stars, which, with other evidence, suggests that stars were formerly more closely packed than now. W. W. B.

LIGHT.

1115. *New Form of Interferometer.* **H. P. Waran.** (Roy. Soc., Proc. 100. pp. 419–423, Jan. 2, 1922.)—Describes a form of Lummer-Gehrcke plate in which the optically-worked plate is replaced by a thin layer of water floating on mercury. Much trouble was experienced owing to tremors and unsteadiness of the water surface, but the means adopted for overcoming this difficulty are described fully in the paper. The Fig. shows the arrangement adopted, including the prism used for introducing the light normally into the liquid. It was found necessary to polarise the light in order to obtain a sharp system of bands. It is shown that the resolving power is directly proportional to the length of the plate and that the separation varies inversely as the thickness. In order to obtain sufficient light with a very thin plate it is necessary to increase the breadth, and it is pointed out that increase of both length and breadth can be achieved for a very thin plate much more readily in the liquid arrangement described than with a glass plate.



J. W. T. W.

1116. *Infra-red Frequencies of Selenates and Chromates.* **C. Schaefer** and **M[artha] Schubert.** (Zeits. f. Physik, 7. 4 and 5. pp. 297–308, 1921.)—Some of the crystals at disposal being very small, they were mounted on a glass plate in mosaic fashion by Voigt and Hochgesang, of Göttingen. In the experimental curves the intensity of reflection is plotted as ordinate against wave-length λ in μ. All the single selenates of formula $MSeO_4$ gave a maximum of reflection near 11 μ, and in the presence of water of hydration several weak secondary maxima [not particularly studied]. The exact maxima for the selenates are: potassium (anhydrous) 11·2 μ, manganese (hydrate, as most of the others) 11·36 μ, nickel 11·44 μ, copper 11·52 μ, zinc 11·44 μ, cadmium 11·44 μ. This average maximum of 11·4 μ corresponds to SeO_4; in the previous work on sulphates the SO_4 maximum found was 9 μ [Abs. 940 (1918)]. The isomorphous Na-Li selenate gave 11·38 μ; the double selenates of ammonium with Mg, Mn, Ni, Co, and also the NiK_2 and K_2 selenates, all gave complex maxima (Co excepted) of the same order, *e.g.* 11·28 and 11·36 μ. Special arrangements are made in these measurements to avoid partial polarisation of the light in the spectrometer. In the experiments with polarised light two curves are obtained, for vibrations at right angles to the optical axis and parallel to this axis; the two maxima were for nickel selenate, *e.g.* at 11·36 and 11·46 μ, and the former was greater. In the monoclinic crystals three maxima, *e.g.* of 11·56, 11·32, and 11·18, correspond to the three axes of the nickel-potassium selenate; this accords with observations made on sulphates, carbonates, and nitrates. In the case of the chromates of potassium, sodium-potassium, and magnesium-ammonium the maxima were also between 11 and 12 μ, near 11·3 μ on average, and the reflections were very strong (80 % for Na-K). Potassium dichromate gave maxima at 10·44 and 12·14 μ, and a third at 18·12 μ. H. B.

1117. *Infra-red Frequencies of Chlorates, Bromates, Iodates.* **C. Schaefer** and **M[artha] Schubert.** (Zeits. f. Physik, 7. 4 and 5. pp. 309–312, 1921.)—The crystals experimented with, partly mounted in mosaic or compressed powders, were regular (Na salts), tetragonal (Ag), monoclinic (K), rhombic (Cd). The maxima of λ found are simple (regular crystals) or complex. When the λ of the first maximum for compounds of the same metal is plotted in μ against atomic weight, the curve rises from C and N (λ for carbonates and nitrates about 7) to Cl (10), Br (12), I (12·5). The second maximum of λ lies near 16 μ for the chlorates and beyond 20 μ in the other cases. H. B.

1118. *Range of Measurements with Refractometers.* **H. Schulz.** (Zeits. techn. Physik, 3. 3. pp. 90–93, 1922.)—This theoretical paper deals with the working range of refractometers of the Pulfrich type, and the dependence of this range on the constants of the apparatus, particularly the angle and refractive index of the prism used. Numerous tables and diagrams illustrate the theory. The original should be consulted by those interested. A. W.

1119. *Double Refraction of Lanolin.* **H. Rohmann.** (Phys. Zeits. 23. pp. 39–43, Jan. 15, 1922.)—The present paper contains a more complete investigation of the double refraction of lanolin than was given in a previous note on the subject [see Phys. Zeits. 20. p. 256, 1919], the author having recently had occasion since the latter paper to deal with several varying samples of lanolin (wool fat, lanolinum anhydricum or adeps lanæ, etc.). Section 1 considers the refraction exponents of lanolin. The observed phenomenon is as follows: Lanolin investigated by the method of total reflection at a prism exhibits double refraction and gives two polarised limiting values for total reflection at right angles to each other, which vary with respect to each other according as the lanolin is spread upon a prism surface parallel or perpendicular to the incident plane; four refractive indices are therefore in existence, and different varieties of lanolin are distinguished by the relationships between these refraction values. An illustrative table of values for sodium light is included. Section 2 describes the experimental determination of the optic axes. Section 3 investigates the hard component of lanolin. For the explanation of the double refraction, the author had inclined towards homotropy in Lehmann's sense, i.e. on molecular direction, since the varieties of lanolin are only slightly turbid; also he investigated whether an accidental double refraction was to hand, as in the case of strained glass, since lanolin possesses a definite rigidity with a kind of elasticity limit. A simpler explanation, however, was found in that from lanolin hard substances can be extracted which exhibit far stronger double refraction than the original material, and these appear to be distributed throughout as small crystals. It is to the orientation of these crystals of the hard component that the double refraction of the lanolin layer must be ascribed. Section 4 describes the Herschel interference at a thin crystal plate. Section 5 deals with orientation in the electric field, wherein no change in the double refraction could be found. Section 6 describes experiments in which dyestuff crystals were formed in lanolin, *e.g.* sodium indigo sulphonate, from whose interference effects the author opined that conclusions with respect to orientation might be drawn; paucity of experimental data, however, prevented a decision as to whether the crystals were uniformly orientated *per se* or whether the direction of spreading was the main factor concerned. The author claims his method to be superior to that of Dieselhorst and Freundlich. H. H. Ho.

1120. *Infra-red Reflecting Power of Silica.* **C. Schaefer** and **M[artha] Schubert.** (Zeits. f. Physik, 7. 4 and 5. pp. 313–315, 1921.)—The authors test a dense quartz from dolomite; a hornstein or white chrysoprase; a green chrysoprase; a chalcedony, finely fibrous; two opals ($SiO_2 + H_2O$); and fused quartz. The first four gave substantially the same curves with a complex maximum near 9 μ, and a high reflecting power (80 to 90 %). The curves of the opal and of the fused quartz distinctly differ from the others; the maxima are in the same positions, but they are less high (50 % reflecting power) and of different shapes. In the case of opal there is no indication at all of the presence of water near 3·2 μ. H. B.

1121. *Scattering of Light by Dust-free Liquids.* II. **W. H. Martin** and **S. Lehrman.** (J. Phys. Chem. 26. pp. 75–88, Jan., 1922. Roy. Soc. Canada, Trans. 15. Sect. 3. p. 50, 1921.)—Measurements of the light scattered by dust-free liquids were previously made [Abs. 1581 (1920)] in round bulbs, which latter had a considerable disadvantage in that they acted as lenses, the power of which varied with the contained liquid, whereby the exciting beam of light was converged to a different degree by different liquids. This difficulty was mentioned in a former paper, but it is only since then that a suitable modification has been devised to overcome it, and this is described in section 1 of the present paper. The relative intensity and the polarisation of the light scattered by various liquids have been measured with an accuracy greater than that previously attained, this being made possible by the use of cross-shaped containers, with sealed-in, flat, glass end-plates in place of the bulbs used heretofore. Section 2 deals with the measurement of the relative intensity and polarisation of the scattered light, and section 3 with two-component solutions. The data for two-component liquid solutions show that the relative intensity of the scattered light is always somewhat greater than that calculated on the assumption that the scattered light is an additive property for the two liquids. Liquids which polarise the scattered light only partially, show on dilution much more complete polarisation. Section 4 examines the ratio of incident to scattered light. The results show that ether and water scatter about one-tenth as much light as do the same weights of these liquids in the gaseous state. For benzene and its homologues the ratio is about one-fifth. Since the manuscript of this paper was sent forward, the ratios of exciting to scattered light have been measured also for the mercury green and sodium yellow lines, and a comparison of these ratios for the three wave-lengths shows that the intensity of the scattered light varies inversely as the fourth power of the wave-length. The same method was used as described in the paper for λ4358 Å. H. H. Ho.

1122. *Colour and Polarisation of the Light scattered by Sulphur Suspensions.* **B. Ray.** (Indian Assoc. for Cultivation of Science, Proc. 7. Parts. 1 and 2. pp. 1–12, 1921.)—The problem of the scattering of light by small suspended particles has attracted a great deal of attention in view of its bearing on the explanation of the blue colour of the sky and sea. Rayleigh has studied the colour and polarisation of the light scattered in different directions by very fine suspensions of sulphur, and the present author extends this work to much larger particles. He finds that for the larger particles the curves representing the intensity of the light scattered in different directions become of an oscillatory character, the phenomena being markedly different for light having its electric vector parallel and perpendicular to the plane of scattering containing the incident and scattered rays. Rayleigh observed that at the early stages, as the particles increase in size, the position of max. polarisation shifts towards the source. With still further increase in the size of the particles, a neutral direction appears nearly at $\theta = 0$, which gradually begins to shift towards $\theta = 180°$. Between the neutral direction and $\theta = 0°$, the state of the polarisation of the scattered light is reversed. Rayleigh observed such reversion only with blue light, but the present author has pushed the investigation to larger particles and obtained such reversal with red light, and traced further the movement of the position of the neutral direction to about $\theta = 180°$. In the earlier stages, as the particles form, it is found that the parallel component shows more pronounced fluctuations of intensity and colour than the perpendicular component, the latter showing hardly any trace of variation of intensity with direction. As the particles increase in size the position is reversed. The perpendicular component now shows a larger number of oscillations, and the colours in it are more prominent than those of the parallel component. Tables are given showing the alteration of colour sequence. The intensity curves are somewhat like those published by Proudman, Doodson, and Kennedy for perfectly conducting particles except that the characters of the curves for the two components are here interchanged. The difference is due to the fact that in this case particles of sulphur are being dealt with which are transparent and not perfectly reflecting. In order to explain the phenomena, the theoretical formulæ have been numerically computed for the case in which $ka = 5$, where k is the dielectric constant of the material composing the spherical particle and a is its radius, and the results are found to agree with the observed facts. H. H. Ho.

1123. *Emission of Light.* **A. Einstein.** (Preuss. Akad. Wiss. Berlin, Ber. 51. pp. 882–883, 1921.)—A theoretical discussion is given of an experiment proposed for the purpose of obtaining information as to the nature of the emission of light from atoms. A. W.

1124. *Einstein's Aberration Experiment.* **C. V. Raman.** (Nature, 109. pp. 477–478, April 15, 1922.)—In a previous paper [see preceding Abs.) Einstein has described an arrangement which he suggests might serve to decide between the classical theory of light and the theory in which light is regarded as made up of single quanta of energy emitted discontinuously from luminous atoms. The author of the present paper draws attention to a fallacy in Einstein's reasoning which invalidates it. The error lies in Einstein having neglected the important part which diffraction plays, according to the wave theory of light, in the theory of the formation of images of illuminated apertures by optical instruments.

A. W.

1125. *Dispersion of Optical Glass.* **T. Smith.** (Optical Soc. of America, J. 6. pp. 57–66, Jan., 1922.)—Compares the formulæ which have been proposed by Conrady and by Wright for the dispersive relations of optical glasses. Conrady's formula is a special case of the type $\mu = a(\mu_F - \mu_C) + b\mu_D + c$, where $b + c = 1$. Wright's formula [see Abs. 1269 (1920) and 303 (1922)] is equivalent to the assumption $b = 1$. These two cases lead to very divergent conclusions on the possible properties of achromatic lenses, so that it is of importance to determine which formula fits the facts most closely. Tables are given for the corrections required, on each formula for μ_A, μ_C, μ_F, and μ_G, for 91 of the Jena glasses. It appears that each formula holds well over the centre and red end of the spectrum, but Conrady's formula is much superior at the blue end. In particular Wright's formula fails for the dense barium crowns. In the case of very dense flints neither formula is satisfactory. A formula suggested by Nutting is found to be quite unsatisfactory.

J. W. T. W.

1126. *Calculation of a Centred Optical System of any Number of Surfaces.* **R. Boulouch.** (Comptes Rendus, 174. pp. 450–453, Feb. 13, 1922.)—Describes a method for the rapid calculation of the optical constants of a centred system of any number of surfaces separating media of given refractive indices. The paper is naturally mathematical and cannot be usefully abstracted. J. W. T. W.

1127. *Colour Temperature of High-Efficiency Sources by the Rotatory Dispersion Method.* **J. G. Priest.** (Optical Soc. of America, J. 6. pp. 27–41, Jan., 1922.)—Describes applications of the method previously described [see Abs. 1417 (1921)] for the measurement of colour temperature. Incidentally the colour temperature of a gas-filled lamp, used as the comparison source in the work, was found to be 2848° K. by calculation from the computed value of the wave-length of centre of gravity, and this value agreed exactly with the temperature found by colour-match with a black-body radiator. The colour temperature of a tungsten 500-watt Mazda C lamp was measured over a range of efficiencies from 12 to 39·2 lumens per watt. The colour temperature at this latter efficiency was found to be 3644° K., whereas the true temperature of the melting-point of tungsten is 3673° K. Measurements were also made of the colour temperature of the crater of carbon arcs. For solid carbons it was found to be 3780° K., and for cored carbons 3420° K., the uncertainty being about 50 deg. in each case. J. W. T. W.

1128. *Spectrographic Study of the Return to its Original State of Barium Platinocyanide in the Villard-Effect.* **A. Zimmern** and **E. Salles.** (Comptes Rendus, 174. p. 80, Jan. 3, 1922.)—It is a well-known fact that fluorescent screens which have turned brown under the action of X-rays

(Villard-effect) are able to return to their original state when exposed to diffuse light. This phenomenon has been attributed by some to a dehydration, by others to a molecular transformation of the salt, with a change from one isomeric form to another. The object of the present research is to find which are the radiations of the luminous spectrum that bring about this regeneration. For this purpose a band of barium platinocyanide which has been subjected to the action of X-rays up to tint B of the dosimetric scale is then exposed to the radiations from an electric arc. It is found that regeneration appears, even after several hours' exposure, only in well-determined bands: up to the present four have been counted. It thus appears that the radiations capable of destroying the Villard-effect are distributed in four principal bands of nearly equal breadth: the lowest is situated entirely in the infra-red, starting at the limit of the visible red; a second is in the yellow-green, a third in the blue, and a last, more slow to appear, in the ultra-violet. A. E. G.

1129. *New Means of Systematic Control of Photographic Negative Processes.* **W. Schlichter.** (Zeits. techn. Physik, 3. 2. pp. 63–64, 1922. Paper read at the Deutsch. Physikertag, Jena, Sept., 1921.)—The photographic negative process is known to be accompanied by a series of uncertainties. These are discussed, and a means of overcoming them is suggested. A. E. G.

1130. *Effect of Temperature on Sensitivity of X-Ray Emulsions.* **A. Zimmern.** (Comptes Rendus, 174. pp. 453–455, Feb. 13, 1922.)—Describes the results of experiments on the effect of rise of temperature on the sensitivity of plates exposed to X-radiation. The temperature range covered was 15° to 85° C.; above the latter temperature fogging took place. The densities obtained, on the Scheiner scale, were as 2·5 to 1 between 85° and 15°, and 2 to 1 between 60° and 15°. At 60° the exposure may be two-thirds of that at 15° for the same density. The effect is not noticed when a reinforcing screen is used, as the long waves from the latter behave like light-waves for which the sensitivity increase is not noticeable. The effect does not seem to depend on the hardness of the rays; it is slightly more marked with a thick emulsion, and it appears to be greater for feeble than for strong impressions. Its application would seem to be of advantage in cases where it is undesirable to use a reinforcing screen, as, for example, in spectrographic work at feeble intensities. J. W. T. W.

1131. *Diffusion of Light and of X-Rays by a Transparent Homogeneous Body.* **L. Brillouin.** (Ann. de Physique, 17. pp. 88–122, Jan.–Feb., 1922.)—A mathematical paper dealing with the diffusion of light and X-rays by transparent substances, homogeneous and crystalline. The question of thermal agitation is discussed. A. B. W.

1132. *Minimum Time Necessary to Excite the Human Retina.* **J. H. J. Poole.** (Phil. Mag. 43. pp. 345–348, Feb., 1922.)—Lodge has suggested that there might be a minimum time necessary for a beam of light to liberate an electron from a photoelectric surface [Abs. 1254 (1921)]. It was deduced that for ordinary sunlight a duration of 1/1000 sec. might be needed, but this appears improbable in view of the fact that photographs can be taken in sunlight by exposures shorter than this. The author has endeavoured to ascertain whether any such limit exists for the human retina. The method is based on the reflection of a beam of light from a rapidly revolving mirror. If the reflected beam and the slit through which it is viewed can both be kept narrow, if the speed of rotation of the mirror is high, and if the distance between mirror and slit is large, the duration of the flash of light can be made very small. The mirror was mounted on a Legendre centrifuge revolving at speeds up to 8000 r.p.m. The nature of the mirror, the optical arrangements, and the precautions necessary in making the experiment are described in detail. A sector disc was also introduced in the path of the beam with the object of causing the mirror to be only illuminated during a fraction of one complete revolution, thus ensuring that only one complete flash reaches the eye during each light-interval. The light becomes very faint, and importance is attached to the eye being in a dark-adapted state. It is concluded that a flash of 2×10^{-7} sec. is still visible; a flash of duration 8×10^{-8}, however, is invisible, but it is uncertain whether this is due solely to the smaller duration or simply to the decrease in energy available. J. S. D.

1133. *Germanium. II. Arc Spectrum.* **J. Papish.** (Chem. News, 124. p. 3, Jan. 6, 1922.)—A brief review is given of the literature on the arc spectrum of germanium. The greater part of the arc spectrum lies in the ultra-violet. Of two visible lines, λ4266·724 is so close to a prominent calcium line (λ4266·870) that the two overlap and appear coincident when examined through an instrument of average dispersion. The other line (λ4686), in the blue, is both intense and sharp when a prism spectroscope is used, and is very suitable for the identification of germanium. Exner and Haschek found the line λ4686 in the spark spectrum. For identification tests the material is carried in the lower (positive) pole of a carbon arc operated at about 10 amps. A Hilger constant-deviation spectrograph with flint-glass prism was found suitable for the examination of the spectrum given by the arc, an exposure of only 2 or 3 secs. being necessary in most cases. A. W.

1134. *Absorption Spectrum and Fluorescence Spectrum of Iodine Vapour. Difference to be Expected from Lenz's Theory.* **P. Pringsheim.** (Zeits. f. Physik, 8. 2. pp. 126–131, 1921.)—A discussion of Lenz's theory of resonance spectra [Abs. 443 (1921)] leads to the conclusion that it is to be expected that the members of higher term number of the resonance spectrum will not be strongly absorbed by cold iodine vapour. This conclusion was confirmed by experiment. Correspondingly, the fluorescence spectrum excited in iodine vapour by white light is not a simple inversion of the absorption spectrum, but is considerably richer in lines, and so the colour-changes of the fluorescence in iodine vapour of higher density are only partially explained by reabsorption of the fluorescent light. In iodine vapour at higher temperature, resonance lines of higher term numbers are more strongly absorbed. The colour-changes in the emission spectrum of iodine vapour of constant density (whether the spectrum is the fluorescence spectrum or excited by an electric discharge) caused by raising the temperature, cannot as yet be explained theoretically. A. W.

1135. *Selected Radiations Emitted by Specially-Excited Mercury Atoms.* **H. J. C. Ireton.** (Roy. Soc. Canada, Trans. 15. Sect. 3. pp. 131–140, 1921.)—A brief discussion is first given of the emission and absorption of radiation by the mercury atom, the discussion being based on Bohr's theory. Experiments are then described which were made with the object of testing the ideas advanced. In particular an attempt was made to see whether it was possible for mercury atoms to emit radiation of the wave-lengths λ5460·97 and λ4046·78, when they had previously been made to absorb successively light of the wave-lengths λ2536·72 and λ4358·66. Results were obtained which lend support to the idea. Some experiments were also made in which it was found that mercury atoms which had absorbed radiation of wave-length λ2536·72 were in the condition to absorb and subsequently re-emit the wave-length λ4358·66, while ordinary unstimulated atoms of mercury were not. Work on similar lines by Fuchtbauer [Abs. 446 (1921)] confirms the results now obtained. A. W.

1136. *Rotation Spectra and Isotopy.* **A. Haas.** (Zeits. f. Physik, 4. 1. pp. 68–72, 1921.)—The pure rotation spectrum lies in the extreme infra-red. There may be a fundamental vibration, natural to the atom of frequency ν_0 in the near infra-red, the rotation-vibration spectrum. When this latter is called forth by the displacement of an electron within the atom, the constellation of the electrons, the electric forces and size of the atom, and hence the moment of inertia of the molecule, will be affected, and a band is produced by the superposition of these oscillations upon an optical fundamental frequency. The three spectra will differ only by their quantum numbers and their moments of inertia, and for any given quantum number and ν_0 the frequency of the lines will be a function only of the molecular moment of inertia. This consideration renders the spectroscopic identification of isotopes possible. If we have a molecule of two atoms of masses m_1 and m_2, and m_1 has an isotope of mass $(m_1 + \mu)$—where μ is a small integer—then the molecule m_1m_2 will have the moment of inertia $J = a^2 . m_1m_2/(m_1 + m_2)$, where a is the distance between the two atoms. When m_1 is replaced by its isotope, a will approximately remain unchanged, but the new J_1 will be $= a^2(m_1 + \mu)m_2/(m_1 + \mu + m_2)$; hence $J_1/J = 1 + \alpha$, and $J/J_1 = 1 - \alpha$ (approx.), so that $\alpha = \mu m_2/m_1 (m_1 + \mu + m_2)$. Every line of the rotation spectrum will become a doublet. This is applied to the chlorine atoms of Aston, of atomic weights 35 and 37; there would be molecules of masses 70, 72, 74 showing triplets. The band spectra would require very delicate measurements. But the differences of 0·01 Å.U. in the visible spectrum would very largely be magnified in the infra-red. The author's own measurements are not sufficiently advanced to give figures. H. B.

1137. *Absorption Spectrum of Liquid and Gaseous Oxygen.* **W. W. Shaver.** (Roy. Soc. Canada, Trans. 15. Sect. 3. pp. 7–14, 1921.)—An examination was made of the absorption spectrum of oxygen, both in the liquid state and in the gaseous state at a pressure of 140 atmos., between the wave-lengths λ7000 and λ2150. In the visible region 8 absorption bands were noted in the case of liquid oxygen, and 7 with gaseous oxygen. In the ultra-violet part of the spectrum four broad bands were found both with liquid and also gaseous oxygen, each made up of a set of finer triplet bands. The wave-lengths of these bands were measured and are given in tables; those in the gaseous absorption spectrum were found to be slightly shifted towards the violet. Experiments on the absorption spectra of nitrogen and ozone (the two most likely impurities present in the oxygen) showed that the bands observed were most probably due to oxygen itself, and not to either of these two possible impurities. **A. W.**

1138. *Spectra of Helium, Hydrogen, and Carbon in the Extreme Ultra-violet.* **J. C. McLennan** and **P. A. Petrie.** (Roy. Soc. Canada, Trans. 15. Sect. 3. pp. 15–29, 1921.)—The authors draw the following conclusions from the investigation described :—(1) The wave-lengths $\lambda = 1931$ Å.U., $\lambda = 1657$ Å.U., and $\lambda = 1561$ Å.U. frequently obtained in the spectrum of helium, as well as others of less intensity, have their origin in the atoms of carbon. (2) The series of wave-lengths whose frequencies are given by $\nu = 4N(1/2^2 - 1/n^2)$ exists for the spectrum of the spark discharge in helinm. (3) In identifying the wave-lengths obtained in vacuum grating spectra of helium, and possibly also of hydrogen, care should be taken to make due allowance for the possibility of wave-lengths being recorded on the plates which have their origin in carbon or mercury introduced into the discharge tube either during the exhaustion of the spectrograph or the purification of the gases. **A. B. W.**

1139. *Absorption of K, X-rays of Silver in Gases.* **P. W. Burbidge.** (Phil. Mag. 43. pp. 381–389, Feb., 1922.)—The total absorption coefficient of silver K-radiation has been measured in air, CO_2, SO_2, and CH_3I, the mass absorption coefficient (μ/ρ) in these cases being respectively 0·55, 0·55, 2·70, and 18·1. Using this silver *k*-radiation, it has been shown by direct tests on four mixtures that the absorption in gases is atomic (as in the case of solids and liquids) and therefore additive in mixtures and compounds. **A. B. W.**

1140. *Ionisation Potentials of the Halogen Hydrides.* **P. Knipping.** (Zeits. f. Physik, 7. 4 and 5. pp. 328–340, 1921.)—The work of ionising a monatomic atom Z may be represented by $Z \longleftarrow I \longleftarrow \overset{+}{Z}, \overset{-}{e}$. The series emission of the again neutralised atom has its limit in the ultra-violet defined (Einstein) by $eV = h\nu$. In the case of diatomic molecules of atoms x and y (which may be the same) the ionisation may be into: $\overset{+}{xy}, \overset{-}{e}$ (positive molecule ion and electron); $\overset{+}{x}, y, \overset{-}{e}$ (positive atom-ion, neutral atom, electron); $\overset{+}{x}, \overset{-}{y}$ (one positive, one negative atom-ion); x, y (both neutral atoms). The last case is unknown and theoretically impossible. The work of ionisation will not be the same in the three other cases, the natures of the different ions cannot be determined, and the radiation bands cannot be interpreted. But (Haber) the complete ionisation of HCl requires energy (Q splitting into atoms), and ionisation I of the H atom, the free electron satisfying the affinity of chlorine E, so that $Q + I - E = X$; the X can be calculated after Born and Fajans. The author describes experimental verifications, by the electronic collision method of Franck, for HCl, HBr, HI, and also for HCN and I_2, all specially purified. The whole apparatus was heated up to 300° until the gas liberation from the walls, etc., ceased. The method was improved by devising a special registration apparatus for working with accelerating potentials. About 500 curves were taken, and the results are in good accord. The ionisation potentials found: HCN 15·5 volts, HCl 14·4, HBr 13·8, HI 13·4, are by a few decimals higher than those of Born and of Fajans, and slightly higher also than the value of Foote and Mohler for HCl. The usual assumption that the ionisation of HCl yields a positive H ion and a negative Cl ion would thus be confirmed. The results also coincide with Franck-Steubing's spectroscopic determination of the electronic affinity of iodine and of bromine. H. B.

1141. *The X-Ray "Faserdiagramm."* **M. Polányi.** (Zeits. f. Physik, 7. 3. pp. 149–180, 1921.)—The author assumes that a crystalline body has a simple ideal "fibrous" structure, if all crystal particles in it lie in a known crystallographic direction relative to a fixed direction on the body. The paper deals with the theoretical cases of X-ray "fibrediagrams" for monochromatic radiation incident on the body. A. B. W.

1142. *Variation of X-ray "Brems-strahlung" with the Direction of Emission.* **A. March.** (Phys. Zeits. 23. pp. 84–86, Feb. 15, 1922.)—From theoretical considerations, the author deduces a complex mathematical expression for the ratio of the intensity of radiation in the direction θ, to that in the direction 90°. Intensity curves are given showing the effect of the wave-length of the X-rays at different values of θ. A. B. W.

1143. *Orbital Motions of Electrons in Atoms, and X-Ray Reflection.* **M. Yamada.** (Tôhoku Univ., Sci. Reports, 10. pp. 423–431, Dec., 1921.)—A mathematical paper based on Debye's observation [Abs. 1271 (1915)] that the origin of X-ray scattering is the electrons revolving round the positive nucleus; i.e. the acceleration of the vibration caused by the incident wave produces the secondary wave, the acceleration of the orbital motion having no relation to the scattering; the positive nucleus is considered to have no effect by virtue of its mass. A. B. W.

1144. *Analysis of Crystal Structure by Means of X-Rays; Simple X-Ray Tube.* **W. Gerlach.** (Phys. Zeits. 22. pp. 557–559; Disc., 559, Oct. 1 and 15, 1921. Paper read at the Deutsch. Physikertag, Jena, Sept., 1921.)—Deals with the determination of the grating constants of various substances, including the following:—Oxides of magnesium, calcium, strontium, and barium; fluorspar and silicon. **F. Kirchner.** (Phys. Zeits. 23. p. 114, March 1, 1922.) A. B. W.

1145. *The Kα Lines of Light Elements.* **V. Dolejsek.** (Comptes Rendus, 174. pp. 441–443, Feb. 13, 1922.)—For the heavy elements, in general, only two Kα lines have been measured, namely, $K\alpha_1$ and $K\alpha_2$. For the elements S — Na, Hjalmar [see Abs. 1176 (1920)] has found five new components, viz. α_3, α_4, α_5, α_6, and α'. The author now gives the results of his measurements of the Kα lines of the elements Zn — Cl. These results are tabulated and are discussed in relation to similar results by the observers. A. B. W.

1146. *Regular and Irregular Doublets.* **A. Sommerfeld** and **G. Wentzel.** (Zeits. f. Physik, 7. 2. pp. 86–92, 1921.)—All regular doublets (one L-doublet, two M-doublets, three N-doublets) can be represented accurately by the "relativistic" formulæ, namely:

$$\begin{aligned} L_2 - L_1 &= L\beta - L\alpha' \\ M_2 - M_1 &= L\alpha - L\alpha' \\ M_4 - M_3 &= L\phi - L\phi' \\ N_2 - N_1 &= M\alpha - M\alpha' \\ &= (L\alpha - L\alpha') - (M\beta - M\alpha), \text{ etc.} \end{aligned}$$

If n' is the "radial quantum number," it follows that the "Quantum-sum," $n + n'$, inside each shell is constant. A table of values is given which verifies the accuracy of this statement.

Similarly for the irregular doublets a quantitative formula, in agreement with that of G. Hertz, is also given. Observed deviations from the law of constant $\Delta\sqrt{\nu}$ are explained by means of a relativity correction. A table of values is given which serves as a proof of the formula. A. B. W.

RADIO-ACTIVITY.

1147. *β-Rays and Atomic Number.* **J. L. Glasson.** (Phil. Mag. 43. pp. 393–396, Feb., 1922.)—In this paper the author reconciles the experimental results and theories of Crowther and of Schmidt with regard to their observations on the absorption of fast β-rays by matter. Crowther's results relating to μ/ρ show that this quantity, the mass absorption coefficient, involves two effects, one of which increases steadily with atomic weight, whilst the other is a periodic function of atomic weight. Schmidt, on the other hand, believed that his results proved that there was no periodic effect, and that his results were at variance with those of Crowther. The author investigates Schmidt's observations by a new method, and shows agreement with Crowther's. A. B. W.

1148. *Scattering of β-Rays in thin Metal Foils.* **H. Geiger** and **W. Bothe.** (Phys. Zeits. 22. pp. 585–587; Disc., 587, Oct. 1 and 15, 1921. Zeits. f. Physik, 6. 3. pp. 204–212, 1921. Paper read at the Deutsch. Physikertag, Jena, Sept., 1921.)—Measurements have been made of the scattering of homogeneous β-rays from RaC in (*a*) the region of small angles (up to 15°), and (*b*) the region of large angles (60° and over). There exists a fundamental difference between these ranges, involving the phenomena of "single-" and "multiple-scattering." These two types of scattering follow very different laws. Thus the single-scattering is proportional to the thickness of the scattering layer, whereas multiple-scattering involves a complex relation widely divergent from the simple law of proportionality to thickness. The laws of single- and multiple-scattering have been carefully determined in the case of α-rays by Rutherford and others (Phil. Mag. 21, 669, 1911; etc.). In the case of β-ray scattering the authors obtained the following results:—(1) For the smallest thickness of scattering layer (under 0·01 mm.), the observed scattering is less than that required by the "square-root law." For greater thicknesses the results agree with the measurements of Crowther [Abs. 1607 (1910)] which satisfy the square-root law. (2) The most probable angle of scattering is found to be proportional to mv^2. (3) The heavier elements produce greater scattering than the theoretical amount predicted by proportionality to atomic number. A. B. W.

HEAT.

1149. *Boiling-Point of Salt Solutions under Varying Pressures.* **E. M. Baker** and **V. H. Waite.** (Chem. and Met. Eng. 25. pp. 1137–1140, Dec. 21, 1921.)—The necessity for the measurements given was emphasised in a former paper [see Abs. 11B (1921)]. The solution whose vapour pressure is to be determined is contained in a jacketed glass tube and heated electrically. The temperature is measured by a Pt thermometer, which is kept well wetted by liquid by means of a modified Cottrell pumping tube slipped down over the heater. The pressure is maintained constant by a mechanically acting " vacuum regulator," and accurately measured by a manometer directly connected with the boiling-point tube. Possible sources of error are fully discussed, and so reduced that the boiling-point determinations are within 0·1 deg. C.

It is shown that the boiling-points of aqueous solutions, where the solutions are not saturated, and the solute does not exert an appreciable vapour pressure, conform very exactly to Dühring's rule. That is, all the solutions obey the relationship $K = (t_1 - t_2)/(\theta_1 - \theta_2)$, where t_1 and t_2 are the boiling-points of the solution and θ_1, θ_2 those of water at the same pressures respectively. Curves are given which fully support this conclusion. T. B.

1150. *Fusion of the Sulphides of Zinc, Cadmium, Mercury.* **E. Tiede** and **A. Schleede.** (Ber. Deut. Chem. Ges. 53. B. pp. 1719–1721, Oct. 16, 1920. Dissertation, Berlin, 1920.)—The furnace used in the experiments of the previous paper [Abs. 905 (1922)] consists of steel tube in which a carbon tube is mounted. Some of the material is first rammed into a glass tube in the carbon tube to prevent subsequent contamination with carbon. The sulphides in question sublime in nitrogen atmospheres at ordinary pressure without melting. At 100 to 105 atmos. zinc sulphide, from pure zinc and pure H_2S, melted between 1800° and 1900° to a bright greenish-yellow wurtzit. Cadmium sulphide required 1750° at 100 atmos. for fusion, mercury sulphide 1450° at 120 atmos. H. B.

1151. *Liquefaction of Hydrogen.* **J. C. McLennan.** (Roy. Soc. Canada, Trans. 15. Sect. 3. pp. 31–36, 1921.)—A brief illustrated account of the method adopted in the University of Toronto. The commercial hydrogen of the National Electro Products Co., Toronto, passes from the cylinders through a reducing valve into a holder of 50 galls.; then into the Peter Brotherhood compressor for 170 atmos., through a water separator and potash purifiers into the first cooling bomb, and into a purifier bomb, electrically heated to 400° C., in which any oxygen in the hydrogen is burnt out with the aid of palladium on asbestos; thence into the second cooling bomb and through two more caustic potash purifiers into the multiple coils (cooled by liquid air), finally to escape through the Hampson expansion valve and to be condensed by the expansion. In operating the whole apparatus is first cooled by liquid air until the thermocouples indicate steady conditions; the compressed hydrogen is then admitted, the nozzle valve being kept open until the temperature of the issuing gas sinks below the inversion point; the nozzle is then throttled down. When the oxygen content exceeded half a per cent., solid oxygen choked the coil; the hydrogen must be of 99·5 %. From 600 to 700 lbs. of liquid air can be made by the 50-h.p. plant in 24 hours with a Norwalk three-stage compressor and the Air Liquide machines. H. B.

1152. *The Process of Solidification as a Problem of Heat Conduction.* **H. C. Burger.** (K. Akad. Amsterdam, Proc. 23. 4. pp. 616–627, 1921.) —The equilibrium between two phases has been fully investigated experimentally and theoretically [see Abs. 1106 (1921)]. Little is known, however, about the cases in which there is no equilibrium, but when one phase is converted into another. In the former case, the thermodynamic laws may serve as basis for all considerations, but in the latter such leading principles are entirely wanting. Researches on the dynamics of phase conversion are quite detached, and often restricted to a compilation of empirical data without adequate interpretation. A general theory of dynamics which would include thermodynamics as a special case of its statics is thus very desirable, but whether this is possible from a purely phenomenological point of view remains for experiment to show. The present author has now worked out a general method for the treatment of the special case of the solidification of a chemically simple substance. On transition of a supercooled melt into the solid condition, the following processes have to be sharply distinguished:—(1) Formation of particles of the solid phase in the supercooled liquid. (2) Further growth of each of these particles and also the growth of a particle of the solid substance put into the liquid purposely. This second point only is treated in the present communication, and the particularities which are connected with the anisotropy of the solid substance are not taken into account. The problem is thus simplified, but at the same time the idea of accounting for the formation of the crystalline form is abandoned. The problem to be solved is then stated as follows: Given a supercooled liquid, in which there are one or more pieces of the solid substance, at a definite moment the temperature is given as a function of the place. It is required to determine for every successive moment the temperature as function of the place and the velocity with which the boundary surface of the two phases moves in consequence of the solidification. It has also to be borne in mind that in a substance in which the temperature differs from point to point, conduction of heat takes place. General conditions are first discussed. Section 2 then examines the theory of solidification in a cylindrical tube. The paper is highly mathematical throughout.
H. H. Ho.

1153. *Natural Convective Cooling of Wires.* **A. H. Davis.** (Phil. Mag. 43. pp. 329–339, Feb., 1922.)—In continuation of previous work, [Abs. 478 (1921)] the author investigates the apparent discrepancy between published data for the natural or free convective cooling of thin wires, and the hydrodynamical theory. The hydrodynamical relation may be expressed in the form $H/k = F(\theta d^3/\nu^2)$, where H represents the heat loss per unit length per degree temperature excess of the cylinder, k the thermal conductivity of the cooling fluid, θ the temperature excess of the cylinder of diameter d, and ν the ratio of the thermal conductivity of the fluid to its thermal capacity per unit volume. Using values of k and ν appropriate to individual experiments, such values being calculated in the case of thin wires for the mean temperature of the wire and its surroundings, it is shown that the above relation accurately represents the results contained in the published work of Langmuir for the free convection losses from fine platinum wires at temperature excesses from 200 to 1600 deg. C., of Ayrton and Kilgour for fine wires, Petavel for the heat loss from steam pipes up to 1 ft. in diameter and from a fine wire in various gases, and Kennelly. The hydrodynamical formula developed is therefore seen to be in agreement with the published data for fine wires, provided allowance be made for the temperature changes of the properties of the cooling fluid owing to the high temperatures at which such wires have been usually employed. J. S. G. T.

1154. *Specific Heats of Solid Bodies at High Temperatures.* **M. Born** and **E. Brody.** (Zeits. f. Physik, 6. 2. pp. 132–139, 1921.)—According to Dulong and Petit's law, the specific heat C_v with increasing temperature takes the limiting value $C_v = 3R = 5{\cdot}96$ cal. gm.$^{-1}$. In many cases, however, this value is considerably exceeded, especially as the melting temperature of the substance is approached. There are two causes to which this increase may be attributed. One is the increase in the amplitude of the vibrations of the atom throughout the interval in which there is proportionality between amplitude and restoring force; and in that case the occurrence of new degrees of freedom. Especially in the case of metals is it necessary to consider the degrees of freedom of the conducting electrons, which at high temperatures can take a share in the "heat content." But the increase of the specific heat as we approach the temperature of fusion is more in favour of the first hypothesis, for the melting must cause an increase in the atomic vibrations to such an extent that the structure of the crystal lattice will be disturbed, and it is probable that this violent agitation of the atom makes itself apparent thermally. The authors have therefore set themselves the task of calculating the vibrations of a crystal lattice when the potential energy is expressible not only in terms of the second order, but when expressions of a higher order are taken into consideration. The solution of this problem is also necessary for a rigid theory of the condition of thermal equilibrium of solid bodies. The results of the mathematical investigation only are given, the final result obtained being that $C_v = dU/dT = 3R(1 - 6\sigma RT)$, where σ stands for an expression obtained by analysis and involving quantum numbers the sign of which will determine the increase in the specific heat at constant volume. σ is capable of being expressed as $\sigma_1 + \sigma_2$ where σ_1 depends on terms of the third order and σ_2 on terms of the fourth order of the potential energy. σ_1 is < 0, and $\sigma_2 > 0$. According to Debye the terms of the third degree determine the thermal expansion of the substance; hence we must expect an increase in C_v in those substances which possess large coefficients of expansion. A few available experimental results are quoted which confirm the theory, and the author suggests that further accurate observations be made to test the theory. T. B.

1155. *On the T^3-Law of the Specific Heats of Solid Bodies.* **C. Schaefer.** (Zeits. f. Physik, 7. 4 and 5. pp. 287–296, 1921.)—A mathematical treatment is given of expressions for the energy of a solid body on the quantum theory and the deduction of the specific heats. The total energy U per mol. is according to the Einstein theory $3Nh\nu/(e^{h\nu/kT} - 1)$, whence the specific heat per mol., C_v, is $\partial U/\partial T = 3R \cdot e^{h\nu/RT}(h\nu/kT)^2/(e^{h\nu/kT} - 1)^2$. The specific heat calculated from this expression diminishes much more rapidly with temperature than the observed values. Nernst and Lindemann have improved the agreement by introducing a second frequency $\nu/2$, but their expression also fails at still lower temperatures. Debye, and independently Born and Karman, have gone much further, by considering the solid body as a system of N coupled mass systems with 3 N frequencies. Debye, by considering only 3 N of the possible modes of vibration, obtains for low temperatures the value $C_v = 3R \times 77 \cdot 938\, T^3/\theta^3$, where θ is the so-called characteristic temperature of the body, and is equal to $h\nu_m/k$. This law has been completely established by many observers. The author, however, considers the result to be deserving of a closer scrutiny, and proceeds to consider the condition under which the integration in the expression used should be carried out. He finally shows that C_v at very low temperatures varies exponentially, and concludes that for every body there is a finite but very low temperature below which Debye's T^3-law does not hold. He also shows why the law has been found to be so nearly correct experimentally, and suggests a possible method of working by which it might be possible to detect deviations from the T^3-law. T. B.

1156. *Specific Heat's of Aqueous Salt Solutions.* **K. Jauch.** (Zeits. f. Physik, 4. 3. pp. 441–447, 1921.)—By the method previously described [Abs. 1064 (1915)] measurements have been made of the specific heats at 18° of 25 different salts in aqueous solutions of various concentrations. In order to render the conclusions more general, the results obtained are considered in conjunction with data previously published, especially those given by Thomsen and by Marignac. The available data, referring to 67 salts containing 22 different kations and 13 anions, are of very unequal accuracy, but they lead to certain generalisations.

Comparison of the density, $1 + A_s/100$, with the specific heat, $1 + A_c/100$, of an equivalent-normal ion solution reveals the parallelism between specific heat and specific volume often pointed out during recent years. A_c and A_s increase with increasing equivalent weight of the dissolved salt, although not regularly, $-A_c$ being about twice as large as A_s.

It may be regarded as more fitting to compare with the mass of unit volume (density), not the heat capacity of unit mass (specific heat), but that of unit volume, A_w, which is calculated by means of the expression, $A_w = A_c + A_c(1 + A_s/100)$, and is also negative. The corresponding value, B_w, for a molecule-normal solution, is calculated similarly from B_s and B_c. The values of $-A_w$ and of $-B_w$, mostly at 18°, are given for all the salts considered.

When the values of $10\,A_s$ and $-10\,A_c$ for all the 67 salts are plotted as function of A, the equivalent weight, they are found to be grouped about two curves which are approximately straight lines, with almost the same inclination to the axis of abscissæ. It is evident that the heat capacity, like the mass of unit volume, of a salt solution is determined mainly by the equivalent weight of the dissolved salt and increases with this. The individual values exhibit, however, marked divergencies dependent on the properties of the separate ions, and these may be conveniently investigated by decomposing the constants, A, into the ionic moduli.

Such decomposition is shown to bring out the exceptionally low values of $-A_w$ for the kations, Cu, Zn, La, Sm, and Th, the exceptionally high values of A_w for Al, Ni, Cs, Tl, and Pb, and the periodic crossing of the curves for A_s and $-A_w$ at Li, Na, Cu, Rb, Cs, and Pb. T. H. P.

1157. *Specific Heats of Ammonia, Sulphur Dioxide, and Carbon Dioxide.* **J. R. Partington** and **H. J. Cant.** (Phil. Mag. 43. pp. 369–380, Feb., 1922.)—The method employed was that of Kundt, as modified by Behn and Geiger, the method of filling the gas-tubes being one previously described by Partington [Abs. 1559 (1914)]. If $K' = C_p/C_v$ for an ideal gas, and u is the velocity of sound in the gas, $K' = u^2M/RT$. The true ratio of the specific heats for an actual gas is given by

$$K = K'[1 - 9\pi\tau(1 - 6\tau^2)/64],$$

this equation, due to Nernst, being based on D. Berthelot's equation for the compressibility of gases under pressures not far removed from atmospheric, $\pi = p/p_c$, and $\tau = T_c/T$; where p_c and T_c are the critical pressure and temperature. The difference of the two molecular heats is given by $C_p - C_v = R(1 + 27\pi\tau^3/16)$, also based on Berthelot's equation. From these relations, C_p and C_v are calculated separately. The following results were obtained at 1 atmo. pressure :—

	NH_3 at 14·5° C.	SO_2 at 13·2° C.	CO_2 at 20° C.
C_p/C_v	1·308	1·290	1·303
C_p	8·77 gm. cals.	9·47 gm. cals.	8·76 gm. cals.
C_v	6·70 ,,	7·34 ,,	6·72 ,,

T. B.

1158. *The Transformation Point of Metals.* **M. Kahanowicz.** (Accad. Lincei, Atti, 30. ii. pp. 178–182, Sept., 1921.)—Previous experiments on the emissive power of metals [see Abs. 925 (1922)] showed that nickel exhibited a discontinuity at the temperature of transformation. The experiments now described were made by a similar method for various alloys (nickel steels and platinite). In all cases it was found that the emissive power constitutes a very sensitive test for the detection of transformations, and it possesses the advantage of giving an indication of the quantity of heat given out or absorbed during the action. On the other hand, a good indication of the exact point of transformation is not obtained. Typical curves are shown in the original paper.

J. W. T. W.

1159. *Report on Pyrometry.* **W. E. Forsythe.** (Optical Soc. of America, J. 5. pp. 494–512, Nov., 1921.)—This paper is the 1920 report of the Committee on Pyrometry, and forms a general survey of the subject, including a section on nomenclature and standards, which gives a definition of the systems of temperature description in general use. Optical pyrometers are divided into four classes, and the value of c_2 to be used for extending the scale above and below the standard temperature is 14,350 μ degrees. A table is given for the error which may be introduced at various temperatures by the use of no red glass. The differences between the Wien and Stefan-Boltzmann scales are also tabulated up to 3095° K. The calibration of optical pyrometers is described, with the form of the black body used, and the method of obtaining a fixed point. A set of curves is reproduced for the correction of temperatures calculated with one value of c_2 to those which would be obtained with a different value. Finally, a table of lumens per watt for tungsten at various temperatures radiating in a vacuum is given. J. W. T. W.

1160. *Heat of Vaporisation of Sodium and the Probability of the Passage of the Sodium Atom from the State of Resonance to the Normal State.* **R. Ladenburg** and **R. Minkowski.** (Zeits. f. Physik, 6. 2. pp. 153–164, 1921.)—This is a theoretical paper dealing with the classical theory and the quantum theory of absorption. The assumptions made in the two cases are briefly stated. The measurements employed to obtain experimental values to check the assumptions made in the two theories are described. Measurements are made of the magnetic rotation of the plane of polarisation in the immediate neighbourhood of the D lines, and the results compared with the assumptions made in the theory. A comparison is made between theory and experiment by using the well-known Clausius-Clapeyron equation for the heat of vaporisation. Graphs showing the author's values and those of other experimenters—notably Minkowski, Fuchtbauer, and Zisch—are given. The assumptions made in the theories appear to be closely confirmed by the experimental results obtained. T. B.

1161. *Vapour Pressures of Salts. Alkali Haloids.* I. **H. v. Wartenberg** and **P. Albrecht.** (Zeits. Elektrochem. 27. pp. 162–167, April 1, 1921.)—About 10 gm. of the purified salt is fused in a Pt tube, 25 cm. long, 1·5 cm. diameter, partly made of Pt-Ir alloy to resist the air pressure, at pressures ranging from 50 mm. up to 1 atmo. in an indifferent atmosphere of nitrogen which must be free of all oxygen. Quartz tubes are also used. The tube is placed in a tubular electric furnace and connected with a mercury manometer. Both the drying of the salts and the boiling of some of the highly viscous melts caused difficulties. The salts are potassium and sodium haloids and the caustic hydrates. The boiling-points found are: NaCl 1439°, NaBr 1393°, NaI 1300°, NaOH 1388°, KCl 1417°, KOH 1324°. Plotting decreasing $1/T$ against increasing pressures (log p), the authors obtain parallel lines. The theory of the heat of sublimation is discussed after Grüneisen and Haber. The heat of formation of salt vapour rises with increasing molecular weight, and the values found for the alkali haloids are larger than those of the corresponding hydrogen haloids. Some of the salts decomposed.

II. **H. v Wartenberg** and **H. Schulz.** (*Ibid.*, pp. 568–573, Dec. 1, 1921.)—The experiments are extended to other alkali haloids; the experimental difficulties of dehydration, boiling (with Cs-salts especially) and protection of the thermo-couple were sometimes very great. Plotting the vapour-pressure curves for fluorides, chlorides, etc., separately, it is found that in the F-salts the parallel straight lines lie far apart and come closer together as we pass to chlorides, bromides, and fluorides. If we disregard the doubtful LiI values, the boiling-points of the iodides (Na to Cs) differ by about 50 deg., those of the bromides by 90 deg., chlorides by 140 deg., and fluorides by 450 deg.; the boiling-points of the metals differ by about 700 deg., viz., Cs 670°, Li 1400°. The heat of formation of the salt vapour generally decreases as we pass from Na to K, Rb, Cs; the values for the Na-salts are considerably lower, those of the Li-salts higher, than those of the other metals. The Na-salts have generally higher melting- and boiling-points than the corresponding K-salts; the relation is reversed for the iodides. The highest melting- and boiling-points observed are NaI 988° and 1695°, and LiF 842° and 1676°. H. B.

1162. *Probability Determinations of Movements of Gas Molecules.* **F. Y. Edgeworth.** (Phil. Mag. 43. pp. 241–258, Feb., 1922.)—This paper is a sequel to an earlier one [Abs. 22 (1921)], and is mainly concerned with further arguments re-enforcing each of the three arguments there employed to determine the distribution of velocities in a molecular medley. A proof, based on the incidents of collisions and encounters without the aid of the "H" theorem (third argument), is here offered that the normal distribution is necessary for stability, as well as sufficient.

G. W. de T.

1163. *Fluid Properties in the Neighbourhood of the Critical Point.* **G. Bruhat.** (J. de Physique et le Radium, 2. pp. 303–316, Oct., 1921.)—Section 1 of the paper deals with general hypotheses. Given the specific volume v and temperature T, a fluid in the liquid state is defined without ambiguity by $p = f_1(v, \mathrm{T})$, a continuous and uniform function, where p is the pressure. Similarly for the gaseous state a continuous and uniform function holds for the same variables, $p = f_2(v, \mathrm{T})$, and in each of the domains of liquid and gas these two functions admit of a limited Taylor development to the fourth order. At a temperature higher than the critical, the gaseous state extends to all values of the volume, while below the critical temperature the regions of the gaseous and liquid states are limited by two values u and u', the specific volumes of liquid and vapour in equilibrium corresponding to the same pressure p of the saturated vapour. The hypothesis which permits the theoretical study of fluid properties in the neighbourhood of the critical point is that of the continuity of the liquid and gaseous states, i.e. the functions f_1 and f_2 form a unique function, and the development of the function f_1 is equal to that of f_2 upon the separation limit of the liquid and gaseous regions, i.e. for the critical isotherm above the critical pressure. The continuity hypothesis is completed by that of the existence of the critical point, at which the function f may take a limited expansion to the 4th order. Section 2 considers the limiting value of $dp/d\mathrm{T}$, which towards the critical point tends towards a finite limit which is not zero, but equal to f'. Experiment indicates clearly the existence of this limit. In section 3 the limit of du'/du is investigated, as also the heat of vaporisation. It is shown that $d\mathrm{L}/d\mathrm{T}$ increases indefinitely in absolute value as the critical point is approached. Section 4 studies the inclination of the rectilinear diameter, and section 5 the limiting value of $d^2p/d\mathrm{T}^2$. Section 6 deals with the refraction of the critical adiabatic, which is found to make a finite angle with the saturation curve and to undergo a finite refraction. In section 7, condensation along the critical adiabatic is examined, and in section 8 a study is made of the adiabatics in the vicinity of the critical adiabatic.

H. H. Ho.

SOUND.

1164. *Frequency-Sensitivity of Normal Ears.* **H. Fletcher** and **R. L. Wegel.** (Nat. Acad. Sci., Proc. 8. pp. 5–6, Jan., 1922.)—In this investigation an air-damped receiver was held tightly against the ear by means of a head-band. It was actuated by an alternating current which was sent from a vacuum-tube oscillator having a range of frequencies from 60 to 6000 cycles per sec. By means of a specially constructed attenuator the current entering the receiver could be varied about three-millionfold by moving a single dial switch. The system was calibrated so that from the reading of the switch and the current entering it the alternating pressure impressed upon the ear cavity could be determined in degrees per cm.^{2}. The measurements were made in a sound-proof room, the top, bottom, and sides of which were built of a number of alternate layers of loose felt and sheet iron, the final inside layer being felt covered with cheese cloth. To make a measurement the vacuum-tube oscillator was set to give the desired frequency; the attenuator dial was then moved until the sound for the receiver reached the threshold of audibility. Measurements were made on 93 normal ears. The results are shown in a graph plotted with r.m.s. pressures as ordinates (on a logarithmic scale) against frequencies as abscissæ. The graph shows about one-tenth of a dyne per cm.^{2} for a frequency of 60 per sec., then changes continuously and smoothly, asymptoting to about 0·0007 of a dyne per cm.^{2} at a frequency of about 2000 per sec. Those requiring pressures of one-tenth of a dyne per cm.^{2} at this frequency (or a hundredfold) are called slightly deaf. Results by other observers are also shown on the graph. E. H. B.

1165. *Analysis of Sound.* **G. Barlow** and **H. B. Keene.** (Roy. Soc., Phil. Trans. 222. pp. 131–166, Feb. 21, 1922.)—The first part of this paper consists of an experimental analysis of sound in air and water and the approach towards a sound spectrum; the second part (obtained by the first author in 1916) is the theory of analysis of an electric current by periodic interruption. The first or experimental part is the application of the second or theoretical part. The principle of this method may be put as follows: The alternating-current circuit contains a d.c. galvanometer and also an interrupter, of which the speed can be varied over the whole range of frequency to be investigated. Generally the intervals during which the circuit is open and closed are equal. When the interruptions synchronise with any component A sin $2\pi nt$ of the current, the galvanometer responds by giving a steady deflection of magnitude depending on the phase difference. The galvanometer actually measures $A\pi$. In making the analysis the frequency of interruption is slowly increased over the whole range. The interrupter had one slip-ring and four interrupted rings, with 1, 4, 16, and 64 ebonite segments. This was driven by a motor. This apparatus was used to analyse (1) a close pair of simple harmonic currents (obtaining a resolving power), (2) a current containing harmonic series, (3) a complex current. Analyses were then made of a fork, a voice, organ pipe, diaphragms and resonators, pure tones and complex sounds. Analyses of sounds in water were then carried out with special apparatus, as shown by diagrams, which should be referred to in the original for these details, which are too elaborate for abstraction. E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1166. *Approximate Calculation of the Capacity of a Plane-parallel Electrostatic Field from the Nature of the Lines of Force.* **J. Spielrein.** (Archiv f. Elektrot. 10. pp. 371–373, Jan. 28, 1922.)—An expression is derived for the total curvature of the equipotential surfaces in an electrostatic field and applied to calculate the capacity of a plane-parallel field in which the equipotential surfaces are cylindrical. J. S. G. T.

1167. *The Electrical Molecular Field.* **R. Gans.** (Ann. d. Physik, 66. 6. pp. 396–414, Feb. 7, 1922.)—The behaviour of a substance, whose molecules are now regarded as systems of electric charges, depends on the field which is produced at the locality of a given molecule by the remaining molecules. The present paper deals with the evaluation of this field via a study of paramagnetism, in which an hypothesis by Markoff is utilised. Markoff's derivation is incomplete, and an attempt by Laue [see Abs. 95 (1916)] is not sufficiently rigid, while Castelnuovo has employed a method which, though free from objection, involves such limitations as to render it unserviceable for generalised considerations. Finally, Holtsmark [Abs. 753 (1919)] has proposed what he believes to be a general solution, which, however, is now shown to be incorrect, since the Markoff-Castelnuovo result is only valid at a very dense molecular distribution, while the Holtsmark solution, on the other hand, gives the limiting case at extremely small density distribution. The present author claims to have produced a general formula which is strictly valid. Section 1 deals with the probability function; and section 2 with the special function $\beta_p(z)$. Section 3 considers limiting cases of the probability function, and section 4 the second approximation to the probability function. The paper is entirely mathematical. H. H. Ho.

1168. *Potentials of Moving Electric Charges.* **A. Anderson.** (Phil. Mag. 43. pp. 131–138, Jan., 1922.)—" Liénard's criticism " [Abs. 1298 (1921)], the author observes, of his former paper [Abs. 691 (1921)], " though quiet, touches only a slight error in notation; the results of the paper are not affected thereby." In order to make the matter clearer he gives, in much greater detail, the analysis by which the scalar potential and the components of the vector potential at P are obtained. These expressions being true for every point and for every distribution of moving electricity, *it would seem* to follow that for a single charge e at Q moving in any manner they are as given in his former paper, but he admits some misgivings as to the validity of the last step in his argument. He considers, however, that the expressions given have some advantages over those obtained by neglecting the square of u/c. For consider a point charge e in uniform rectilinear motion. Taking $e/4\pi r(1 - u_r/c)$ as the potential, that at any point in the line of motion is $e/4\pi a$, where a is the distance of the point from the moving charge, which is independent of the speed; but it would seem that, if the speed approaches that of light, the potential at any point of the line in front of the particle should tend to zero. Again, if a sphere be described round the moving charge as centre, and the integral of normal force due to the moving charge be taken over its surface, it will be found that, with the simpler expression for the potential, the value of the integral is $ec/2u \log \left\{(c+u)/(c-u)\right\}$, whereas with the expression given above, it is e, in accordance with Gauss's theorem. G. W. DE T.

1169. *Dielectrics and Newtonian Relativity.* **E. Carvallo.** (Comptes Rendus, 174. pp. 106–109, Jan. 9, 1922.)—From the conclusion arrived at by the author in a recent paper [Abs. 618 (1922)] it would appear at first sight that while the flux of magnetic induction in conductors is subject to Newtonian relativity, this is not the case in dielectrics. This, the author maintains, is the origin of the conflict between theory and observation in the Michelson-Morley experiment. According to the Fresnel-Fizeau law $(K - 1)v/K$ is the amount of drag of a light-wave in a body of specific inductance K moving with velocity v relative to the source, and this expression vanishes in air when the density vanishes. Hence, the author states, has arisen the hypothesis that the air plays quite a secondary part in the transmission of the wave by an ether assumed to be fixed and so capable of serving as a framework of reference for the absolute velocity of the earth through space. Considering, however, the objective facts only, let a source of induction S, considered as fixed, carry the reference system $Oxyz$, then $-(\partial Z/\partial y - \partial Y/\partial z) = \partial \alpha/\partial t (x \text{ constant})$. Passing to a parallel system, $O_1x_1y_1z_1$, parallel to the former and moving with velocity v_1 (assumed parallel to Ox), relatively to S. The above equation then becomes $-(\partial Z/\partial y_1 - \partial Y/\partial z_1) = \partial \alpha/\partial t(x_1 \text{ constant}) - v_1\partial \alpha/\partial x_1$. An observer on the system O_1 sees the source with a velocity $v_0 = -v_1$, so that the equation becomes $-(\partial Z/d\partial y_1 - \partial Y/\partial z_1) = \partial \alpha/\partial t(x_1 \text{ constant}) + v_0\partial \alpha/\partial x_1$, and will hold for any system moving translationally with respect to the first. It will hold, therefore, for a system attached to S. Hence, a wave from a movable source S will travel through space just as if space, considered as a material body, were carried along by the translation of the source. That is to say, a source in translation carries with it its train of electromagnetic waves, just as a magnet carries with it its magnetic field. If this law be accepted—and the author claims that it seems imperatively demanded by the facts—no electro-optic observation would reveal a translation of the entire system. The author further observes that Sagnac's remarkable experiment showing that rotation of the apparatus affects the luminous phenomena, in the same way that the earth's rotation affects a Foucault pendulum, will be explained at the same time, the only modification required in the author's analysis being the addition to the velocities considered of the velocity v of the source. Sagnac's calculation will not be affected, since the circulation of the vector v round the closed contour of the luminous ray is zero. G. W. DE. T.

1170. *Electric Conductivity in the Free Atmosphere.* **A. Wigand.** (Ann. d. Physik, 66. 2. pp. 81–109, Nov. 22, 1921.)—Observations of conductivity have previously been made in free manned balloons by Gerdien up to 6 km. and the present author up to 4·1 km., both showing a general increase of both λ_+ and λ_- with height as mountain observations had suggested. The present paper gives the result of observations by Gerdien's aspiration method during four balloon ascents in which the max. height reached was 8·9 km. The increase is found to extend to these higher regions, and indeed at an accelerated rate. At 8·9 km. the highest measurement of total conductivity $(\lambda_+ + \lambda_-)$ was $26 \cdot 57 \times 10^{-}$ e.s. unit, being 80 times the mean of the surface values measured before leaving and after landing. The rate of increase in the lowest layers, with mist or haze, is small and may even be negative [see also Abs. 1130 (1921)]. The relative magnitudes of λ_+ and λ_- are considered. The measurements show the ratio $q = \lambda_+/\lambda_-$ as frequently less or greater than unity, so that there is no typical preponderance of conductivity of one sign in the free atmosphere. There is, however, a connection between q and cloud formations. With Cu and CuNb and a thunder tendency λ_- is in excess at the cloud levels, while with stratiform clouds q is greater than unity below the sheet, but less than unity above. Time variations of the conductivity are also discussed. M. A. G.

1171. *Potential Gradient and Vertical Conduction Current in the Free Atmosphere.* **E. Everling** and **A. Wigand.** (Ann. d. Physik, 66. 4. pp. 261–282, Dec. 20, 1921.)—As part of an investigation of the electrical conditions in the free atmosphere, carried out at Halle, measurements were made in the year 1913 of conductivity for positive and negative ions in relation to meteorological factors, and simultaneously of potential gradient, at various heights up to 9 km. during four ascents in a free balloon. Preliminary reports appeared soon afterwards [see, *e.g.*, Abs. 1094 (1914)], but the full results have only recently been published. Conductivity $\lambda_\pm$ is dealt with in a separate paper [see preceding Abs.], the present paper dealing with potential gradient dv/dh during two of the ascents and with the vertical current i deduced from the relation $i = dv/dh(\lambda_+ + \lambda_-)$. Potential gradient was investigated by a "single-collector" method due to Everling, depending on the measurement of the p.d. between the balloon itself and a single collector projecting from the basket. These relative values have been reduced to absolute values by Müller [see Abs. 364 (1922)].

The vertical course of potential gradient in anticyclonic weather was found to be one of rapid decrease with height up to 6 or 7 km., and then a slower decrease, to a value about 4 volts/m. at 9 km. The vertical current deduced from measurements of conductivity and potential gradient also shows a tendency to decrease with height. Marked stratification in the atmosphere (such as at inversions of temperature, with haze or cloud layers) is associated with considerable disturbance of the vertical course of the electrical elements, including the vertical current. The significance of height variations of these elements in connection with the problem of the maintenance of the earth's electrostatic field is discussed.

A. Wigand. (Phys. Zeits. 22. pp. 623–624; Disc., 624–625, Nov. 1 and 15, 1921. Paper read at Deut. Physikertag., Jena, Sept., 1921.)

M. A. G.

DISCHARGE AND OSCILLATIONS.

1172. *Discharge Phenomena with Phosphorescent Quinine Sulphate.* **A. Kalähne.** (Phys. Zeits. 23. pp. 45–47, Jan. 15, 1922. Paper read at the Deut. Physikertag, Jena, Sept., 1921.)—The author describes an interesting investigation of the production of conducting power in the air in the neighbourhood of powdered crystalline quinine sulphate (previously heated to a temperature below 18° C., the melting-point, and then allowed to cool). A. B. W.

1173. *Contact Detectors; Electrochemical Action as Cause of Unipolarity.* **A[ngelika] Szekely de Doba.** (Akad. Wiss. Wien, Ber. 127. IIA. pp. 719–792, 1918.)—In this long-delayed number the author gives the results of a lengthy experimental investigation. The first part deals with the various minerals and metallic points which have been used as elements in contact detectors, some 67 different types being tabulated. The author's own experiments then follow.

Experiments with Galena Detector.—The effect of passing strong and also weak currents (direct, alternating, and h.f.) through the contact is investigated as regards sensitiveness and unipolarity, and also the effect of low and of high temperatures (immersed in oil). Taking the galena-graphite detector, the effect of direct current passing in one direction, is to improve the detector action; current in the reverse direction has a prejudicial effect. Suitable manipulation of the current in the beneficial direction (Ga — Gr) can, at certain places on the curve, increase the sensitivity tenfold. A considerable current in the adverse direction (Gr — Ga) passed for some time will ruin the detector. On again applying the adverse current the detector action becomes again slightly sensitive, but the *direct current* obtained from the detector *has its direction reversed.* Application of the "beneficial" current results in the restoration of the normal condition. It is found that the effect of the beneficial current on the characteristic is to increase the unipolarity, with consequent improvement of the sensitiveness. Alternating currents of low or high frequency have an effect similar to that of direct current, and it is concluded that the action of the adverse component of the alternating current outweighs that of the beneficial component. The experiments tend, the author thinks, to confirm the view that the detector action is due to a film of moisture between the contact of the two substances used, the detector behaving like a small galvanic cell. L. H. W.

1174. *Calculation of Integral Effects by Means of Heaviside's Rule.* **K. H. Warfvinge.** (Archiv f. Elektrot. 10. pp. 374–377, Jan. 28, 1922.) —Heaviside's method is applied to calculate certain integral effects, more especially the integral values of the square of the current, the dynamometer action and the condenser voltage in two inductively-coupled oscillating circuits. J. S. G. T.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1175. *Electrical Resistivity of Dilute Metallic Solutions.* **A. L. Norbury.** (Faraday Soc., Trans. 16. pp. 570–596; Disc., 597–602, July, 1921.)—Earlier work is discussed, and it is stated that in insoluble series sometimes the conductivity and sometimes the resistivity is a linear function of the atomic composition. Guertler's formula for the resistivity of mutually soluble metals is discussed, as is the effect of cold work and crystal size on the resistivity. This is very small in pure metals and solid solutions, but more important in duplex alloys.

Effect of added elements on resistivity.—The effect of the addition of one atom per cent. of various elements to Fe, Co, Ni, Pd, Pt, Cu, Ag, Au, Mg, and Cd in the solid state, and Cu, Na and K in the liquid state, is investigated. It is shown that the "atomic resistivity increase" is, in general, approximately proportional to the distance in the periodic table between the various solutes and the solvent element. *Discussion of results.*—There is no obvious analogy, from the electrical resistivity point of view, between solid solutions and aqueous solutions. It is suggested that the large increase of resistivity, produced in a metallic conductor by the introduction of a few foreign atoms, is due to the solute atoms exciting forces on the electrons of their neighbours. J. L. H.

1176. *Natural Frequency of Coils.* **C. Ridder.** (Archiv f. Elektrot. 10. pp. 339–370, Jan. 28, 1922.)—A method is described in which, by means of a Braun tube, the natural frequency of single-layer or multilayer coils may be found. The external magnetic and electric fields of such coils are rendered visible by the Braun tube. Many illustrations of the method are given. The results obtained show that two- and three-layer coils exhibit a frequency spectrum which is very different from that for single-layer coils. The natural oscillations of the second kind (potential resonance) for these coils have no fixed place in the frequency spectrum, but depend on the conditions of experiment, especially on the capacity of the coils to earth. The natural oscillations of the first kind (current resonance) have a strong external magnetic field and a weak electric field. This is reversed in the case of natural oscillations of the second kind. In the case of flat coils a frequency spectrum was found similar to that for single-layer coils. *Immersion of coils in oil.*—Single-layer and two-layer coils were investigated in oil, and it was found that the increase to be expected in the natural oscillations was not proportional to the square root of the dielectric constant of the oil used, but was smaller than this. [See Abs. 1073B (1921).] A. W.

1177. *Effect of Thermoluminescence on Electrical Conductivity.* **C. A. Mackay.** (Roy. Soc. Canada, Trans. 15. Sect. 3. pp. 95–100, 1921.)—On the basis of the commonly accepted theories as to the mechanism of photoluminescence it might be expected that the electrical conductivity of matter is greater during the emission of light than in its normal state. Nichols and Merritt, however, have shown that the conductivity of eosin is unchanged when this substance emits fluorescent light, under the action of ultra-violet light. Experiments have been carried out with crystals of calcite, fluorite, and felspar, all of which exhibit thermoluminescence when gently heated. It was found that the thermoluminescence of all three crystals caused an increase in the electrical conductivity of these substances. When calcite was excited to thermoluminescence more than once, successive excitations produced smaller increases in the electrical conductivity. Exposure to X-rays partially restored the crystal of calcite to its original condition, so that the electrical effect of thermoluminescence was nearly as great as initially. A. W.

1178. *New Form of Electrometer.* **L. Amaduzzi.** (N. Cimento, 23. pp. 77–95, Jan., 1922.)—Describes an electrometer which consists essentially of a gold-leaf electroscope of which the containing box is of metal with an adjustable opening. The whole electroscope is insulated, and connected to one pole of the source, while the other pole is connected to a metal plate placed at a convenient distance from the electroscope. The opening in the latter is adjusted to give the best sensitivity. Two windows are provided in the electroscope box, for enabling a picture of the gold leaves to be thrown on a scale. The relation between opening and voltage has been found to be of the form $V = ax^2 + bx + c$. The instrument has been constructed in two forms, one with a rectangular box and the other with a cylindrical box for the electroscope. The chief advantages claimed for this instrument are ease and safety in use, and absence of energy consumption. It is equally useful for continuous or alternating potentials. A form of electroscope for radiology measurements is described in a second part of the paper. J. W. T. W.

1179. *Quick-Action Registering String Galvanometer.* **E. v. Angerer.** (Zeits. Instrumentenk. 42. pp. 1–6, Jan., 1922.)—A detailed description of the instrument, including reproductions of the records given by it. An investigation was made of the effect of temperature, and of secular change of the tuning-fork used for regulating the film speed. It was found that the greatest variation in the number of vibrations per sec. was less than 1 in a thousand. It was found also that the absolute error of a single exposure point was less than 0·001 sec. J. W. T. W.

ALTERNATING CURRENTS AND MAGNETISM.

1180. *Magnetisation Discontinuities revealed by the Valve Amplifier.* **B. van der Pol.** (K. Akad. Amsterdam, Proc. 23. 4. pp. 637–643, and 7. pp. 980–988, 1921.)—The author has made some investigations of the noises due to magnetisation discontinuities noticed by Barkhausen [Abs. 443 (1920)]. His first experiments on wires were made with a 3-stage low-frequency amplifier, and led to the view that the magnetism of long filaments of molecule-groups is reversed as a whole so that the direction of the group coincides with the external e.m.f. The same sounds are, it is found, also produced by stretching, torsion or heating of the wires. A previously unnoticed property was observed, namely, that a strong circular magnetisation causes, so long as it lasts, a superposed longitudinal magnetisation of the rod to take place *without* discontinuities. Further, when an annealed iron wire has received from a magnetised coil its remanent magnetism, this latter may be destroyed by bending the part of the rod within the solenoid in alternate directions; the characteristic sounds being emitted. When afterwards this bending is continued, the characteristic sound remains audible, though weaker. A freshly annealed wire that has *not been magnetised* before shows this last effect, the sound being repeated indefinitely with the same intensity. This is held to be in favour of Weiss's theory of spontaneous magnetisation of iron crystals.

The second paper deals with a further series of experiments in which a sensitive moving-coil galvanometer was used, without amplifier. Plotting hysteresis curves with the aid of a magnetometer, it was found that the sounds only occur on the steep parts of the curve. Photograms of the deflections obtained are reproduced. As an instance of the number of clicks obtained for a change in field, it is stated that for nickel steel 1554 clicks were found for a change of field of 6·0 to 6·7 gauss, and for iron 1546 clicks for a change from 4·8 to 5·5 gauss. The total number for a complete reversal is estimated at 5000 and 6500 for the two substances respectively. L. H. W.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1181. ***Ion-Mobilities, Ion-Conductances and Effect of Viscosity on Conductance of Salts.*** **D. A. McInnes.** (Am. Chem. Soc., J. 43. pp. 1217–1226, June, 1921.)—The product $T_{Cl}\Lambda$, where T_{Cl} is the transference number of the chlorine ion and Λ is the equivalent conductance of a chloride solution, expresses the contribution of the chlorine to the conductivity of the solution, and is constant up to about *N*/10 [Lewis, Abs. 892 (1913)]. At higher concentrations it is higher for solutions of low viscosity than for solutions of high viscosity, but becomes constant if multiplied by the viscosity raised to the power of 0·7; this factor has already been found by Green (*ibid.*, 93. p. 2049, 1908) to give constant values for the limiting conductance of lithium chloride in solutions made viscous by the addition of sucrose. T. M. L.

1182. *Fibre-Structure of Metals. Copper and Tungsten Wires.* **M[argarete] Ettisch, M. Polányi,** and **K. Weissenberg.** (Zeits. f. Physik, 7. 3. pp. 181–184, 1921.)—Becker, Herzog, Jancke, and Polányi having shown that in the fibrous structure of hard-drawn wires the axis of the fibre is that of the wire, the authors find that in tungsten wire the fibration is in the direction of the face diagonal of the elementary cube, whilst copper has a double fibration, in directions of the spacial diagonal and of the edge of the cube. The paratropic directions are hence (110) for tungsten and (111) and (100) for copper. There might be other directions as well; but the character of the diagrams indicates that a further search is unnecessary. H. B.

1183. *Structure of Tungsten.* **H. C. Burger.** (Phys. Zeits. 23. p. 14, Jan. 1, 1922. Paper read at the Deut. Physikertag, Jena, Sept., 1921.)—Experiments made in the same way as those of Weissenberg show that in the tungsten filament the crystals are so arranged that the faces of the rhombic dodecahedra are at right angles to the axis of the drawn wire. The drawing does not appear to affect the lattice, which were the same as that of powdered tungsten of different origin. Yet the intensity maxima of the ring curves are rather flat, suggesting that the faces are not all strictly normal to the axis; but absorption has to be considered, and the rays reflected in different directions do not all travel the same distances through the metal. When the radiation is heterogeneous (not homogeneous) the continuous blacking of the plate is not radially symmetrical; and in a wire which has previously been raised to incandescence the blacking is dissolved into many black points which are due to the production of large crystals. The bulb used has a perforated kathode of Al, an antikathode of copper, and a window of nickel which only allows the α-rays of copper to pass. H. B.

1184. *The Slip Interference Theory of the Hardening of Metals.* **Z. Jeffries** and **R. S. Archer.** (Chem. and Met. Eng. 24. pp. 1057–1067, June 15, 1921.)—Hardness is defined as resistance to permanent deformation. Metals owe their hardness and strength to the attractive forces between their atoms. The regularity of the atomic arrangement gives rise to certain planes of weakness. When an external load produces a shearing stress on such a plane, which exceeds the resistance of the crystal to shear on that particular plane, fracture of the crystal takes place. Generally, the crystal fragments adhere and merely slip over each other. The result of such slip, repeated on many planes, is a permanent deformation, i.e., the crystal is ductile. The hardening and strengthening of metals by any of the known methods may be considered as due principally to interference with slip.

Hardness of Solid Solutions.—In general, metals are hardened and strengthened by the addition of elements which form solid solutions with them, and it appears that the atoms of the solute replace those of the solvent without substantial change in the space-lattice of the latter, up to the limit of solubility. The increased hardness and strength are probably traceable directly to increased interatomic forces, the attraction between unlike atoms being, in general, greater than between like atoms. We may conceive an additional mechanical factor in the form of a roughening of the slip planes, due to the presence of atoms of unlike size, or a staggered arrangement of the atoms [see Abs. 1628 (1921)]. The structural constituents in alloys which possess the greatest specific hardness and strength are the intermetallic compounds. In general these compounds are of a low order of symmetry, which, together with the large interatomic forces involved, accounts for their great hardness.

Ageing of Duralumin.—The author accepts the theory advanced by Merica, Waltenberg, and Scott, to explain the age-hardening of duralumin. An important point in this theory is the conclusion that there is a certain average size of particle which produces maximum hardness, which is designed "critical dispersion." It is possible to increase the hardness of Al tenfold by producing within the grains of a Cu-Al alloy a critical dispersion of hard particles.

Hardness of Manganese Steel.—It is shown that in the early stages of hardening manganese steel the changes are strikingly similar to those found in the hardening of duralumin.

Hardness of Martensite.—It is stated that when the cooling rate of austenite is sufficiently rapid to form martensite, the transformation of the γ iron to α iron is substantially complete, whereas the formation of cementite is not complete, and that the hardness of martensite may be attributed chiefly to a combination of two factors—the super-refinement of the ferrite grains, and the strengthening of the ferrite by carbon. *The tempering of martensite* involves two changes: ferrite grain growth, and the precipitation and growth of cementite particles. Ferrite grain growth causes progressive softening. The precipitation of cementite causes hardening, but the growth of the particles above the critical size produces softening. J. L. H.

1185. *Thermal Treatment of Aluminium Alloys.* **R. Guillet.** (Comptes Rendus, 173. pp. 979–982, Nov. 21, 1921.)—A continuation of some earlier work (in conjunction with others) on the hardening of duralumin [Abs. 178 (1920)]. The author makes up various binary, ternary, and quaternary alloys of Cu, Si, and Mg with Al, and measures their hardness after various heat-treatments. He finds that the Al-Si-Mg and Al-Si-Cu-Mg alloys are the only ones that harden appreciably on heat treatment. As a result of a micrographic study, he deduces that:

(1) the simultaneous presence of Si and Mg is necessary to obtain important hardening, while the further addition of Cu increases this hardness still more. (2) Mg_2Si is practically insoluble in the quenched material, while the greater part of the $CuAl_2$ disappears. (3) Annealing precipitates the dissolved compound in a state of fine division, the Mg_2Si acting as a catalyst. J. L. H.

1186. *Lead-Thallium Alloys.* **L. Guillet.** (Rev. de Mét. 18. pp. 758–760, Dec., 1921.)—Alloys of lead and thallium were cast into moulds of a Cu-Al alloy, the base of which was polished and, after etching, were suitable for microscopic examination without further polishing. The results confirmed the work of earlier investigators. Hardness tests showed that the minimum hardness occurred at a composition corresponding to the compound $PbTl_2$. J. L. H.

1187. *Mechanism of Failure of Metals from Internal Stress.* **W. H. Hatfield.** (Faraday Soc., Trans. 17. pp. 36–46; Disc., 58–81, Dec., 1921.)—The author points out that the direct cause of " season cracking " is internal stress, and discusses the various ways in which such stress may be set up. He then criticises the " amorphous theory " explanation of season cracking, and gives tables showing the mechanical properties of a 65/35 brass under different conditions of treatment, also showing that increasing the time of loading from 18 secs. to 16 mins. has not resulted in any alteration of the breaking load. Finally he considers the properties of the amorphous film as disclosed by corrosion and chemical attack. J. L. H.

1188. *Failure of Metals through the Action of Internal Stress Irregularities.* **J. N. Greenwood.** (Faraday Soc., Trans. 17. pp. 123–138; Disc., 58–81, Dec., 1921.)—The author first considers the origin of internal stresses in metals and classifies them into two groups: (*a*) those due to distortion by cold working, and (*b*) those due to suppression or depression of a phase change. He then considers the case of steel, with special reference to tool steel, and shows that quenched steel can be in a state of internal stress from three causes: (*a*) The retention of iron in the γ form, the tendency being to revert to α with increase in volume; (*b*) the suppression of the carbide phase change, with a tendency opposite to (*a*); (*c*) the completion of the carbide phase change. The effect of this is very small. The influence of free carbide and non-metallic inclusions in weakening steel is shown to be similar, while Mn and Cr are shown to reduce internal stress irregularities by making the quenching effect more uniform throughout the piece. J. L. H.

1189. *Uranium Steels.* **H. S. Foote.** (Chem. and Met. Eng. 25. pp. 789–792, Oct. 26, 1921.)—Gives the results of an examination of a series of steels of similar carbon content and with increasing amounts of uranium present, made in charges of two tons or more in an electric furnace. Hypo-eutectoid steels containing not more than 0·6 U are normally pearlitic, but any increase in U over this figure produces a characteristic carbidic component which heat-tints in a manner similar to uranium carbide. The residue obtained by treatment of pearlitic steels containing not more than 0·6 U indicates that the U is combined with carbon, but there is not sufficient evidence as to whether the U forms a true double carbide or a mixture of carbides of Fe and U. Uranium exerts little influence on the transformation points up to 2·0 %; over this percentage the Ar transformations are lowered and markedly suppressed even at normal rates of cooling. Steels having the lowered transformations are characterised by a martensitic structure, while those having the points suppressed or nearly so, exhibit the polyhedral structure of gamma iron and austenite.

Uranium steels when quenched, sometimes contain microscopic white crystals which do not heat-tint like uranium carbide, and which are only etched by aqua regia. These appear to be double or complex carbides of Fe and U. Uranium, as an alloying element does not need to be augmented or intensified by the addition of other elements and uranium steels lend themselves to water quenching.

Uranium increases the hardness and hardening power of steels by means of its ability to emphasise the characteristics of the cementite; the harshness imparted thereby is not accompanied by as great a degree of brittleness as that induced by other carbide-forming alloys. Carbon-uranium steels are particularly suitable for uses which necessitate a low drawing temperature, in that they possess under these conditions, a remarkable combination of hardness, strength, and ductility.

Results are given of mechanical tests on a number of uranium steels and uranium-nickel steels. The latter, as compared with pearlitic nickel steels, show higher elastic limits for the same ductility, are harder when heat-treated, are more susceptible to heat treatment, and possess superior dynamic toughness and resistance to fatigue when properly heat-treated. A metallographic study of U high-speed steels indicates that U tends to promote the formation of complex carbides on which the cutting efficiency and property of "red hardness" depends. A comparison between the microstructures of uranium and uranium-free high-speed steels annealed at the same temperature shows that the former contains, in general, a larger number of carbide globules than the latter. C. O. B.

1190. *Grain Growth due to Critical Strain in Aluminium.* **A. P. Knight.** (Chem. and Met. Eng. 25. pp. 829–830, Nov. 2, 1921.)—In the manufacture of aluminium coffee pots the metal is cold-drawn from circles, annealed at 425° C. (800° F.) and put through a tapering operation which enlarges the diameter of the bottom. It was found that the bottom of the pots had a very rough surface due to large crystal size, caused by annealing of metal which had undergone critical deformation. Annealing at 370° C. (700° F.) instead of 425° C. completely cured this defect. J. L. H.

1191. *Etching Reagents for Nickel.* **H. S. Rawdon** and **M. G. Lorentz.** (Chem. and Met. Eng. 25. pp. 955–956, Nov. 23, 1921.)—Discusses various etching reagents suitable for etching nickel, monel metal, and other nickel alloys, and recommends the use of concentrated hydrochloric acid as a contrast-etching reagent. The use of this reagent with copper alloys is also discussed. J. L. H.

1192. *Internal Stresses in Brass Tubes.* **R. H. N. Vaudrey** and **W. E. Ballard.** (Faraday Soc., Trans. 17. pp. 52–57; Disc., 58–81, Dec., 1921. Engineering, 111. p. 421, April 8, 1921.—Abstract.)—Certain brass tubes, when expanded on to a conical plug, showed an apparent stratification into at least two layers. By preparing "hollow sunk"

tubes and comparing the time taken by them to fracture in mercurous nitrate solution, both before and after layers had been turned off the inside, the outside, and both inside and outside, the authors showed that regions of high stress exist near the sides of the wall, falling off very rapidly as the wall was entered and being of different sign on the two sides. With a consistently worked tube the stress changes uniformly through the tube wall. In the *discussion*, **H. Moore** questioned why injurious stresses were allowed to remain in tubes when they can be simply and cheaply removed. **E. A. Smith** supported the author's conclusions.
J. L. H.

1193. *Cupric Etching Effects Produced by Phosphorus and Oxygen in Iron.* **J. H. Whiteley.** (Iron and Steel Inst., J. 103. pp. 277–289; Disc., 290–302, 1921. Engineering, 111. pp. 628–630, May 20, 1921.—Abstract.)—Describes an investigation carried out to determine whether the cupric reagents of Rosenhain and Haughton, Stead, le Chatelier and Dupuy, and the author, will detect small variations of the phosphorus content only, synthetically produced in samples of electrolytic iron and to endeavour to produce in iron samples, variations of the oxygen content only which could be detected by the cupric reagents. The method used is in part an adaptation of one devised by Stead, and consists in the former case of phosphorising thin strips of the metal in hydrogen and then welding together a pile consisting of alternate strips of phosphorised and non-phosphorised material to form a composite piece in which the phosphorus content alone varied so that the effect of known variations could be ascertained. A similar method has been employed in the endeavour to obtain an uneven distribution of oxygen. The results show that differences in the phosphorus content of less than 0·02 % in adjacent parts of otherwise pure iron can be readily discovered by these reagents, and as the difference is increased, at any rate up to 0·15 %, the contrast becomes more and more pronounced. When oxygen is present, white resist lines are formed only at the weld junctions, but these resist lines are not formed when unoxidised iron is welded in dry hydrogen.
C. O. B.

1194. *Influence of Mass on Heat Treatment.* **E. J. Janitzky.** (Chem. and Met. Eng. 25. pp. 783–784, Oct. 26, 1921.)—The hardness of a heat-treated steel is shown to be expressed by the following equation: $B = 14 \cdot 125u/(D - d) + b$, where B = the Brinell hardness, n and b are constants depending on the composition of the steel ($n = 10$ and $b = 175$ for a 0·45 carbon steel), D is the diameter of the section, and d is a constant given by: $d = D - 14 \cdot 125u/(B - b)$. Hardness numbers are calculated for a number of steels investigated by the British Engineering Standards Association and compared with the results obtained by them. In general the accord is very good.
J. L. H.

1195. *Chemical Properties of Alloys.* **G. Tammann.** (Zeits. f. Metallkunde, 13. pp. 406–419; Disc., 419–424, Sept., 1921.)—The limits of attack by chemical reagents set by the composition of alloys, *e.g.*, of Au-Cu [see Abs. 566 (1921)], are referred to the distribution of the atoms in the crystal lattice and to the shielding influence which this distribution may afford to the one or the other metal in mixed crystals. The author then discusses the electrochemical properties of alloys. In couples consisting of a corrodible metal B, solution of a salt of this metal and an alloy with a more noble metal A, the potential difference is influenced by the internal diffusion. When this diffusion is unimpeded, as in liquid amalgams, very small proportions of metals like zinc suffice to impart to the mercury the potential of the less noble metal. This holds also for alloys which are liquid at higher temperatures, provided they give a continuous series of mixed crystals or of solutions; in such cases the first portion of the less noble metal B has a much stronger influence than further additions of B to A. At temperatures at which internal diffusion is obstructed, the B constituent, if less noble than hydrogen, will already be attacked by moist air, and the surface layer will hence only contain atoms of A; the potential rises abruptly to that of A. The case of Au-Cu is not quite of this type, and the rise of potential more gradual, probably because gold dust accumulates on the surface of the alloy. In silver-gold alloys the silver is the less noble metal, here not attacked by air and water; the potential remains that of silver up to high percentages of gold, but not when the silver is dissolved by nitric acid. When there are gaps in the series of mixed crystals (Zn-Cu) the potential changes in steps corresponding to the α, β, γ modifications, and the curves for 18° C. and for 380° (in fused $ZnCl_2$) differ strongly. The paper further deals with polarisation, decomposition potentials, and polarisation currents.

The *discussion* of this paper and of Abs. 1064 (1922) by **Heyn** and others concerned especially the question of alteration of the crystal lattice by electric stress and deformation. **Rinne** mentioned that a sphere of calcite expanded on heating along the *i* axis, contracted along the others, and there were hence some directions in which there was no change in diameter; the distances between the Ca and the CO_3 groups and between the C and O in the leptyl CO_3 must also change. Rock salt was observed to flow under pressure like an extruded metal. Whether the lattice was disturbed was uncertain, as was also pointed out by **Czochralski,** who, however, considered the complete vanishing of dislocated reflection from strongly deformed metals as a proof of a change in the crystal lattice; the recrystallisation of metals further pointed to such a change; but he distinguished between crystal growth and recrystallisation. **Heyn** attributed the increase in hardness accompanying the development of finer grains to the increase in the grain surfaces and in the total stress at these surfaces. **Heike** stated that crystals of zinc diarsenide became much better wave-detectors in radiotelegraphy when some Zn, Sb, or Ag was added to the arsenide. H. B.

1196. *Heat Treatment of Aluminium Bronze.* **A. A. Blue.** (Chem. and Met. Eng. 25. pp. 1043–1048, Dec. 7, 1921.)—The theoretical investigations of earlier workers are reviewed, and a diagram, slightly modified from that of Greenwood, is put forward. Hardness, tensile, compression, and impact tests were carried out on a large number of alloys having a composition not varying greatly from Cu 90 %, Al 9·5 %, Fe 0·5 %, which had been subjected to various heat-treatments, while further tests were carried out on heat-treated samples containing Cu, 88·5; Al, 10·4; Fe, 1·2 %. The following deductions are drawn as a result of these tests: (1) Heat treatment produces marked changes in the hardness of the alloys, but has little or no effect on the yield-point or tensile strength. (2) Forging produces little effect on the tensile properties of the alloys. (3) Aluminium bronze is very difficult to handle in the foundry, and yields uncertain results. (4) Figures have been published for the mechanical properties of this alloy which cannot be duplicated in practice. J. L. H.

1197. *The Amorphous Metal Hypothesis.* **Z. Jeffries** and **R. S. Archer.** (Chem. and Met. Eng. 25. pp. 697–704, Oct. 12, 1921.)—The amorphous metal hypothesis as developed by Beilby, Rosenhain, and others is described and generally accepted by the authors. They reject its application to hardening produced by cold work, pointing out that metals like copper and tungsten remain predominantly crystalline after an amount of work which by the hypothesis would make them entirely amorphous. J. L. H.

1198. *The Elements regarded as Compounds of the First Order.* **S. H. C. Briggs.** (Phil. Mag. 42. pp. 448–456, Sept., 1921.)—Treating the subject from the point of view of the theory of duplex affinity previously developed [Chem. Soc., J. 93. p. 1564, 1908; 111. p. 253, 1917, and 115. p. 278, 1919], the atoms being regarded as compounds of the atomic kernels and electrons built up in accordance with Langmuir's theory of atomic structure [Abs. 991 (1919)], the author directs attention to a striking parallelism between the properties of the chemical elements, on the one hand, and those of the simpler compounds on the other.

It is shown that, if the elements are regarded as compounds of the atomic kernels and electrons, their reactions with each other are precisely analogous to the reactions between binary compounds. There is, therefore, no essential difference between the forces which hold the atoms together in a compound and those which hold the kernels and electrons together in an atom. Thus, if the above theory and those of Rutherford and Lewis regarding the structure of atoms are accepted, the conclusion must be drawn that there are only two elements, namely, Rutherford's proton (hydrion) and electron. The atomic kernels are compound radicals of proton and electron. Some of these kernels combine with electron to give strongly polar substances like the alkali metals, in the same way as the radical ammonium combines with chlorine to give the strong electrolyte ammonium chloride; others, on combination with electron give non-polar substances such as neon, just as the radical phenyl when united to chlorine gives the non-electrolyte chlorobenzene.

According to Werner's classification, simple binary compounds like potassium chloride and platinic chloride are regarded as compounds of the first order, combinations of such compounds of the first order, potassium platinichloride, for example, being designated compounds of a higher order. Since the substances known as the chemical elements are the simplest combinations of proton and electron which are capable of separate and independent existence, it follows that the chemical elements are the true compounds of the first order, Werner's compounds of the first order being really of the second order, and bodies like potassium platinichloride of the third order. Co-ordination is involved in all valency phenomena. T. H. P.

1199. *Effect of Temperature on Platinum Black and other Finely-Divided Metals.* **R. Wright** and **R. C. Smith.** (Chem. Soc., J. 119. pp. 1683–1688, Oct., 1921.)—When a freshly-coated Pt plate is heated to a temperature somewhat above red heat and allowed to cool, the original velvet-black surface becomes grey, the extent of the lightening of colour depending on the temperature and duration of the heating. This change is not attended by any alteration in weight of the metal, and does not take place at any definite temperature, the effect increasing with rise of temperature until at 900° the deposit becomes almost white.

Experiments made with Pt, Ag, and Pd show that the metals increase temporarily in catalytic activity after being heated to certain temperatures, and that the activity gradually falls off as high temperatures are reached. The former effect is explainable by the evolution of occluded gas, the escape of which would not only increase the roughness of the plates but also, in some cases, serve to remove a catalytic poison; the falling-off in catalytic power at high temperatures is probably due to decrease in the specific surface of the deposited metal, accompanied by alteration in the size and number of points at which the liberated oxygen can escape. That such decrease in specific surface actually takes place is shown by measuring the diameters of plated wires of Pt, Ag, Fe, and Cu before and after heating to dull redness in an atmosphere of hydrogen; if the diam. of the unplated wire is taken as unity, the diam. of the plated wire diminished from 1·31 to 1·15, from 1·21 to 1·11, from 2·00 to 1·41, and from 1·66 to 1·36 for Pt, Ag, Fe, and Cu respectively. Further, these metals and also Pd, when deposited electrolytically in a fine state of division, show the phenomenon of sintering at temperatures considerably below their ordinary melting-points. It is considered that this effect may be related to the abnormal vapour pressure and solubility of finely-divided material and that it probably influences the optimum temperature of a finely-divided metal used as a catalyst. T. H. P.

1200. *Relation between the Occlusive Power of Palladium for Hydrogen and its Activity for Catalytic Hydrogenation.* **E. B. Maxted.** (Chem. Soc., J. 119. pp. 1280–1284, Aug., 1921).—It has been previously shown [Abs. 167 (1920), 176 (1921)] that the occlusive power of palladium for hydrogen in the presence of occluded hydrogen sulphide varies linearly with the content of inhibitant, and that the activity of Pt for catalytic hydrogenation is also a linear function, down to a certain point of inflection, of the content of various catalyst poisons. It is evident, then, that the catalytic activity and the occlusive power should also be related linearly to one another. Formerly the inhibitants and catalysts taken for occlusion measurements have not been identical with those employed for determinations of catalytic activity. In the experiments now described, the same inhibitant, lead, has been taken for each series.

The influence of lead on the occlusion of hydrogen by Pd is found to be twofold: the occlusive power is depressed, and the rate at which occlusion takes place is altered radically by relatively high concentrations of lead. Probably for the whole of the curve and certainly for the greater portion, the occlusive power is a linear function of the content of inhibitant, and this is also the case with the catalytic activity over the main portion of the experimental range. The slopes of the two linear curves are, however, not the same. Thus, it requires a ratio of 0·17 gm.-atom of lead to 1 gm.-atom of Pd to reduce the occlusive power to one-half of its original value, whilst only about 0·02 gm.-atom of lead is necessary to reduce the catalytic activity to one-half. To explain this result it is pointed out that, whereas occlusion of hydrogen is not confined solely to the surface of the Pd, catalysis is mainly a surface phenomenon. That the explanation lies therein is supported by the observation that the slope of the poisoning line for catalytic activity varies with the fineness of division of the catalyst, whilst the poisoning coefficient for the inhibition of the occlusive power does not vary from preparation to preparation of the palladium. T. H. P.

1201. *Adsorption of Gases by Metallic Catalysts.* **H. S. Taylor** and **R. M. Burns.** (Am. Chem. Soc., J. 43. pp. 1273–1287, June, 1921.)—The present study has been confined to metals, substances which are chemically active, and which should therefore display adsorptions of a specific nature. Section II of the paper describes apparatus and manipulation; Section III deals briefly with the preparation of the gases used; Section IV gives a more detailed account of the preparation of the metals. A solid catalyst is supported, generally, on some inert porous material so as to present max. surface to the reacting substances, but this has now been avoided owing to a possible specific contribution thereby to the adsorptions. Section V contains an exhaustive discussion of the results obtained, and Section VI of the conclusions arrived at. It is demonstrated that adsorption by the metals investigated is a specific property quite different in nature from adsorption by inert absorbents such as charcoal. The extent of adsorption is shown to be a function of the mode of preparation, and is especially less pronounced the higher the temperature at which the reduced metal is prepared. The analogy of this fact with the corresponding facts of catalytic behaviour has been emphasised. Adsorption isotherms have been studied in two cases, nickel and hydrogen, and copper and CO_2. In both cases, adsorption increases rapidly with increasing partial pressures below 300 mm., and becomes practically independent of pressure beyond this pressure. The significance of irreversible adsorptions of gases by metallic catalysts has been studied in more detail than hitherto, and the reasons for divergencies between different catalysts have been suggested. H. H. Ho.

1202. *Action of Ultra-violet Light on Colloidal Platinum.* **E. B. Spear, P. F. Jones, A. S. Neave,** and **M. Shlager.** (Am. Chem. Soc., J. 43. pp. 1385–1391, July, 1921.)—Since radiations are supposed to favour both the formation of hydrosols and their coagulation, the authors experiment with platinum hydrosol prepared after Bredig, exposing half of the solution to ultra-violet light (Cooper-Hewitt quartz lamp) and the other half to the light after passing through glass. Cooling was required in the former case and stirring in both. The electrolyte was conductivity water or NaCl solution; the temperature did not exceed 22°. The rays coagulated half of the Pt in 10 hours, whilst more than 2 years were required in the ordinary light in conductivity water. In NaCl the rays accelerated the coagulation likewise very strongly, especially when the solution was not concentrated. H. B.

1203. *Disruption Velocity of Molecules.* **K. F. Herzfeld.** (Zeits. f. Physik, 8. 2. pp. 132–136, 1921.)—Recently Polányi has drawn attention to a difficulty which occurs in the theory of gas reaction velocities [see Abs. 179 (1921)]. It concerns the problem of the source from which a molecule obtains the necessary energy for its disruption into atoms. The most plausible assumption is that this energy arises from the impacts experienced by collision with other molecules, but Polányi now abandons this standpoint after a study of hydrogen bromide formation. Bodenstein and Lind from their reaction velocity measurements have concluded that the reaction proceeds in two stages, the first being the disruption of the bromine molecule into atoms and the second the reaction, $Br + H_2 \longrightarrow HBr + H$. Polányi has shown that the energy due to molecular impacts would produce a slower effect than the rate found for hydrogen bromide formation. Since the latter cannot take place quicker than molecular disruption, Polányi concluded that the Br molecule decomposes more rapidly than the energy supplied by impacts. This view does not appear valid to the present author, who finds that hydrogen bromide formation proceeds quicker than the most rapid disruption possible of the bromine molecule, which latter is caused by a side reaction. The hydrogen atom set free in the above equation reacts as follows: $H + Br_2 \longrightarrow HBr + Br$; i.e., for every bromine atom disappearing in the first equation, a replacement occurs by the second reaction. The formation of hydrogen bromide therefore does not decrease the number of Br atoms and does not depend directly on the contribution velocity from the molecules. The author has assumed that the equilibrium between bromine molecules and atoms corresponds to that given by thermodynamics, and he shows that the HBr formation affords no support for the non-mechanical nature of chemical process such as appears to follow from Polányi's considerations. From the latter's work upon the dissociation equilibrium of a diatomic molecule, there follows either the non-mechanical nature of the process or that not all atomic impacts lead to molecular formation, but only a fraction depending on the density of the gases present, which at ordinary pressures and temperatures amounts to about 1/1000. H. H. Ho.

1204. *Statistical Theory of Suspensions and Solutions.* **O. Klein.** (Ark. f. Mat. Astron. och Fysik, Stockholm, 15. No. 5. pp. 1–51, 1921.)—This paper contains the description of a method for the treatment of statistical-mechanical problems which arise in a suspension of small particles in a viscous liquid. The author has in view a possible application of the method to the theory of dilute solutions with consideration of the forces arising between the dissolved molecules, and consequent extension to strong electrolytes. A method is evolved whereby an equation is obtained analogous to that of Gibbs and independent of special hypotheses concerning the mechanical condition of the liquid. It is shown from an hypothesis of Einstein on the connection of the diffusion coefficient of a suspension of independent particles with the average square of the particle displacement in unit time, that the diffusion coefficient of this process is connected in a simple manner with the average square, and may be determined without further hypotheses as to the nature of the liquid. Section I of the paper is concerned with general considerations and definitions of the suspensions investigated. Section II gives a statistical-mechanical treatment of a suspension in which the particles interact with given forces. A general equation is derived for the distribution probability of the suspension, using a similar method to that employed by Einstein for deriving the differential equation for the diffusion of a suspension. Section III elucidates this equation by means of a special example which had been previously investigated by Smoluchowski, and shows how the initial distribution of the positions and velocities of particles gradually passes into that corresponding to the temperature equilibrium. Section IV deals more exhaustively with the general equation, and by approximation an equation is derived which is a generalisation of a differential equation found by Smoluchowski for the Brownian molecular motion under the action of external forces. Section V contains a discussion of the possibility of applying the theory developed to the problem of an electrolyte. H. H. Ho.

1205. *The Theory of Volume Dilatation for Concentrated Solutions.* **A. Schulze.** (Phys. Zeits. 22. pp. 177–179, March 15, 1921.)—On the ground of the physical behaviour of concentrated solutions, the conclusion has been drawn that with two liquids which only consist of mono-molecules, and whose molecules on admixture do not interact, the volume of the mixture is equal to the sum of the volumes of the components. If, however, the molecules influence each other so that a chemical compound results, then on account of the diminution in numbers of molecules, a volume contraction results. If one liquid be ideal and the other complex, *e.g.*, containing di-molecules, then on admixture a volume dilatation may be observed in consequence of a conversion of di-molecules into mono. The volume dilatation as a consequence of association has not yet received theoretical treatment. The conditions are difficult since with associated components two new unknowns are introduced, and the author now derives, by means of the law of mass action, an expression for the volume dilatation of concentrated solutions which is solely dependent on the volumes of the pure components and on the number of molecules in the mixture. The theoretical results are then applied to the mixture of ethyl ether and acetone, which is very suitable for the purpose on account of the fairly high dilatations obtained. The very satisfactory agreement between the observed and calculated data is a proof that the molecular constitution derived from the vapour-pressure measurements over the whole range of concentration is in complete accord with the other physical characteristics. H. H. Ho.

1206. *The Radiation Theory of Thermal Reactions.* **W. C. M. Lewis** and **A. McKeown.** (Am. Chem. Soc., J. 43. pp. 1288–1306, June, 1921.)—Recently Lewis [see Abs. 456 (1920)] pointed out that the observed velocity constant of unimolecular or spontaneous dissociation of a gas was greatly at variance with the value calculated on the basis of Planck's expression for the rate of absorption of energy by an oscillator (there identified with the electron), such absorption being regarded as continuous (i.e., Planck's second formulation of the quantum hypothesis). An even greater discrepancy appeared to exist when an attempt was made to account for the observed velocity constant on the basis of discontinuous absorption of actual discrete quanta of energy (i.e., Einstein's view, which has much in common with Planck's first formulation of the quantum hypothesis). The discrepancy referred to is always in the sense that the observed velocity constant is many times, of the order 10^7, greater than that calculated on the basis of continuous absorption. It appears to be of the same order of magnitude for different unimolecular reactions, and to be independent of temperature. It would at first sight seem that such a discrepancy between theory and experiment would necessitate the discarding of the fundamental assumptions underlying the mechanism of chemical action as embodied in the radiation hypothesis. An attempt is now made in the present paper to demonstrate that such drastic action is unnecessary, and that the disagreement between observation and theory may be eliminated by suitable modification of the formulæ underlying the latter. An expression has been obtained for the velocity of a unimolecular reaction in a gaseous system, on the basis of the radiation hypothesis of thermal reactions, making use of the concept of continuous absorption of radiation by an oscillator. The expression is:

$$k_{uni} = 8\pi^2 e^2 \, . \, n_m^3 \nu^2 \, . \, \epsilon^{-h\nu/kT}/3mc^3,$$

where k_{uni} is the unimolecular velocity constant, e and m are the charge and mass of the electron, ν is the frequency of the radiation characteristic of the reaction, h and k are the constants of Planck and Boltzmann respectively, T is the absolute temperature, and n_m is the refractive index of the substance in an ideal state corresponding to the closest possible packing of the molecules. This term n_m is shown to have a value of approximately 200, practically independent of the system considered and of the temperature. The expression for the velocity constant is found to agree with experimental data of unimolecular reactions, so far as they are known. A comparison is made of the above equation with that suggested by Dushman, namely: $k_{uni} = \nu\epsilon^{-h\nu/kT}$. If these expressions are really equivalent, it follows that $8\pi^2 . e^2 . \nu . n_m^3 = 3mc^3$, that is, $\nu n_m^3 =$ a universal constant. The frequency term, however, varies here, with the nature of the material, and at the same time the present authors have found it necessary to regard n_m^3 as a universal constant. It is evident, therefore, that the two expressions cannot be reconciled. Section II deals with the mass-action equilibrium constant, and by considering reversible reactions of the dissociation type, an expression for this constant is derived. This is shown to be in good agreement with the experimental data on iodine as given by Bodenstein and Stark. Recent criticisms of the radiation hypothesis are considered in Section III, and the authors believe these criticisms to have been met. H. H. Ho.

1207. *Radiation and Chemical Action.* **W. C. M. Lewis.** (Nature, 108. p. 241, Oct. 20, 1921.)—This letter is in reply to Lindemann's criticism of the radiation hypothesis of chemical reactions, namely, that exposure of an aqueous solution of sucrose plus acid to sunlight brings about no sensible increase in speed [see also preceding Abs.].
H. H. Ho.

1208. *Simple Form of Apparatus for Observing the Rate of Reaction between Gases and Liquids, and its Use in Determining the Rate of Solution of Oxygen by Water.* **H. G. Becker.** (Roy. Dublin Soc., Proc. 16. pp. 334–344, Aug., 1921.)

1209. *Anomalous Liesegang Stratifications Produced by the Action of Light.* **E. Hatschek.** (Roy. Soc., Proc. 99. pp. 496–502, Sept. 1, 1921.)

1210. *Mixtures of Anisotropic Liquids and Identity of Grandjean's Stratified Liquids with Liquids of the Type of Azoxyphenetol.* **G. Friedel** and **L. Royer.** (Comptes Rendus, 173. pp. 1320–1322, Dec. 19, 1921.) —Grandjean's equidistant planes can be observed, not only in anisotropic liquids of the second class, such as amyl cyanobenzal-aminocinnamate (*ibid.*, 172, p. 71, 1921), but also in anisotropic liquids of the first class, on the addition of a small quantity of a liquid of the first class. Thus when a mere trace of cholesteryl acetate or benzoate is mixed with azoxyphenetol or azoxyanisol, and the mixture observed between cleavage sheets of mica, the parallel planes are fully developed. Since the cholesterol esters are optically active, the mixture shows all the phenomena (dichroism, reflection of one type only of circularly polarised light) that are seen in the active amyl ester formulated above. The stratified structure can therefore exist in anistropic liquids of both types.

When azoxyphenetol (Type I) and ethyl azoxybenzoate (Type II) are mixed in equal quantities they give a homogeneous isotropic liquid. On cooling, rounded droplets of anisotropic liquid separate (as in pure azoxyphenetol), and the whole mass passes into an anisotropic liquid of Type I. On further cooling rod-shaped masses separate from this (as if from pure ethyl azoxycinnamate), and the whole mass passes into an anisotropic liquid of Type II. On still further cooling, first azoxyphenetol and then ethyl azoxybenzoate separate in solid crystals. It appears, therefore, that the two types of anisotropic liquid are discontinuous phases, and immiscible with one another, and also that in general a compound may exist in both conditions successively, thus:

$$\text{Liquid} \longrightarrow \underbrace{\text{Type I} \longrightarrow \text{Type II}}_{\text{Anisotropic liquids}} \longrightarrow \text{Solid}$$

One or both anisotropic liquids phases may be missing, just as a solid may sublime without melting, but the above scheme appears to represent the general case.

[Errata. *Ibid.* 174. p. 131, Jan. 9, 1922.] T. M. L.

1211. *Theory of the Galvanic Cell.* **Décombe.** (Comptes Rendus, 173. pp. 834–836, Nov. 7, 1921.)—A theoretical discussion of the energy relations in a hydro-electric cell. L. H. W.

1212. *Metastability of the International Weston Cell and its Unsuitability as an E.M.F. Normal.* **E. Cohen** and **A. L. T. Moesveld.** (Zeits. Phys. Chem. 95. pp. 285–304, Aug. 13, 1920.)—Prolonged experiments, details of which are given, prove that the international Weston cell, with its cadmium amalgam of 12·5 per cent., is unsuitable as a standard, because the system is metastable below 12°. There may be a change of 6 millivolts when the element passes into the stable condition. The new experiments confirm the previous researches of Cohen, of Bijl, and of F. E. Smith. An amalgam with 8 per cent. of Cd is stable throughout the temperature range from 0° and a few degrees below 0° up to 40°, as Cohen and Kruyt showed in 1910. The Weston cell recently introduced by the Weston Company, containing an amalgam with from 12 to 13 % Cd, is also unsuitable, and is not even to be considered normal, since it does not contain the sulphate $CdSO_4 . 8/3H_2O$. H. B.

1213. *Trihalogen-Methyl Reactions.* III. *Use of the Silver Kathode in Electro-Deposition of Copper.* **H. W. Doughty** and **B. Freeman.** (Am. Chem. Soc., J. 43. pp. 700–704, May, 1921.)—Copper, cadmium, and zinc are dissolved very rapidly by an ammoniacal solution of ammonium trichloroacetate, whilst with nickel the rate of dissolution is very low and with silver virtually zero; with copper the reaction is highly exothermic. Use may therefore be made of ammonium trichloroacetate for removing electrolytic copper deposits from silver electrodes. Should the silver kathode be tarnished by hydrogen sulphide, it is placed in contact with pure tin-foil in boiling 10 % sodium hydroxide solution until perfectly bright, and is then washed successively with dilute hydrochloric acid, dilute aqueous ammonia, and distilled water; it is then rinsed with alcohol, which is burnt off, and after being allowed to cool in a desiccator is ready for use.

The usual procedure for the deposition of copper from nitric acid solution is followed exactly as when a Pt kathode is used, except that the current must be turned on before the silver kathode is immersed, in order to prevent attack of the silver by the nitric acid. After the final weighing the silver kathode is placed in a wide-mouthed stoppered bottle filled with a 10 % solution of trichloroacetic acid in aqueous ammonia (1 part of aqueous ammonia of sp. gr. 0·900 and 1 part of water). The copper is removed in about 10 minutes, the kathode being then washed and dried as described above.

The trichloroacetic acid may be replaced by chloroform or carbon tetrachloride (this must be free from the sulphur compounds it often contains), but these dissolve the copper more slowly. T. H. P.

1214. *A Colloid Theory of the Corrosion and Passivity of Iron, and of the Oxidation of Ferrous Salts.* **J. A. N. Friend.** (Chem. Soc., J. 119. pp. 932–949, June, 1921.)—The more important of the previous theories of the corrosion of Fe are discussed and compared. They are regarded as insufficient to account for all the phenomena attendant upon the corrosion of Fe, and a theory is suggested which appears to account for the facts in a reasonable manner. A. B. C. L.

1215. *Electrolysis of Aqueous Solutions of Cerium Salts.* **A. B. Schlötz.** (Zeits. Elektrochem. 27. pp. 521–523, Nov. 1, 1921.)—Alloys of cerium and iron which, in different experiments, approximated to the composition Ce_2Fe_3 (62·5 % Ce) were obtained as adherent deposits by the electrolysis of solutions containing varying proportions of ceric and ferrous chlorides, together with a quantity of sodium or potassium lactate, and a small amount of sodium or potassium chloride. The temperature employed varied from 40° to 70° C., and the kathodic current density from 0·4 to 2·0 amps./dm.^{2}. The anode consisted of a spiral of Pt, and the kathode of a cylindrical net of Pt gauze, which was coated previously with lead electrolytically so as to raise the overvoltage and thus hinder hydrogen evolution. The presence of lactate was found to increase the overvoltage by 0·15 volt. The kathode was rotated during electrolysis. In presence of chlorides of other metals than iron, the electrolysis of solutions of cerium chloride did not, as a rule, liberate any cerium in the kathode deposit. J. N. P.

1216. *Determination of the Diameters of Electrolytic Ions by Capacity Measurements.* **A. Günther-Schulze.** (Zeits. f. Physik, 6. 4. pp. 229–236, 1921.)—When a polished metallic surface is exposed to dry air, the oxygen molecules hitting the surface will tend to tear the valency electrons out of the metal, and may then adhere as ions. This transition of electrons liberates heat; when the heat energy is large and the metal soft and of low melting-point (sodium), the metal ions will be torn out of the surface, and an oxide crust will be formed, increasing in thickness. In the case of little energy of evolution and hard metals of high melting-point (tantalum) the oxidation will soon come to a stop. When such a tantalum surface is plunged into a solution of an alkali electrolyte, *e.g.*, cæsium nitrate, the oxidation will proceed, unless the tantalum is negatively polarised to start with. The Cs-ions, oxygen ions, and tantalum will then form a condenser system of capacity $C=f\epsilon/4\pi\delta$, where f is the surface area, ϵ the dielectric constant, and δ the distance between the condenser coatings. The meaning of δ is uncertain; the author takes the distance between the centre of the Cs-ions and the surface of the tantalum, i.e., sum of diameter of oxygen ion plus radius of Cs-ion. The experiments are made by filling a platinum dish, joined to the positive pole of a 2 volt-cell, with solutions of $CsNO_3$ or other alkali nitrates or nitric acid, and dipping a freshly polished rod of tantalum, 4 mm. thick [see next Abs.], joined to the negative pole into the solution. When the oxygen layer has the thickness of one ion only (δ as defined above), the capacity will decrease as we pass from small kations to large kations, Cl, Li, Na, K, NH_4, Rb, Cs. The Li-ions seem to bind 3 molecules of water of crystallisation in the dielectric layer, and appear hence enlarged. The addition of an electrolyte of small kation H to that of a large kation decreases the δ values, because the smaller kation displaces the larger. With increasing temperature (25° to 90°) the capacity increases, not owing to a diminution of the effective kation radius, but probably because ϵ increases. H. B.

1217. *Electrolytic Valve Action.* II. *Polarisation Capacity of Tantalum.* **A. Günther-Schulze.** (Zeits. f. Physik, 6. 4. pp. 237–247, 1921. From the Physikal.-Techn. Reichsanstalt.)—Details of the experimental arrangements and results referred to in the previous abstract. The capacity measurements are made with the aid of a bridge and a buzzer; the polarisation is effected by alternating currents, and in the case of negative polarisation the measuring potential is kept relatively low. With negative polarisation the capacity is practically independent of the polarisation potential (within the limits 0·5 and 2·4 volts), and constant after the first 3 minutes. At polarisation potential 0 the capacity increases considerably with time. The capacity is largest with H-ions, smallest with Cs-ions; traces of H-ions in other electrolytes raise the capacity strongly. The capacity increases with rising temperature, and the effect is reversible so long as the layer has not become too thick; but there is with negative polarisation a temperature for the electrolyte beyond which the polarisation cannot prevent the thickening of the layer. With positive polarisation growth in thickness of the oxide film with increasing polarisation is more marked, and a maximum thickness is approached within about a day, the increase being from 0·0190 $\mu\mu$ in $RbNO_3$ after 1 minute to 0·1345 in 70 mins., and in HNO_3 from 0·1050 $\mu\mu$, after 1 minute, to 0·1432 after 1200 minutes; the cell then resembles a valve cell. H. B.